VOL. I NO. 6

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

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SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK

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THE

JOURNAL
OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

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Announcement

Copies of the 1917 List of Members are still available to members of the Society desiring it. This was issued last August and contains complete alphabetical lists of members and of companies with which members are connected. In addition the Constitution of the Society, the regulations governing the Standards Committee and considerable general information regarding S. A. E. activities are included in the booklet.

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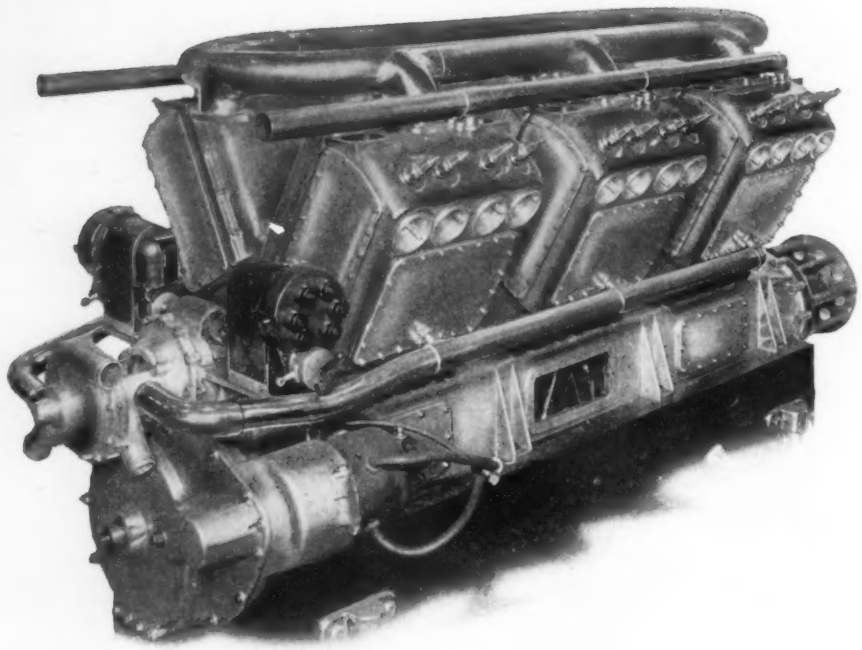

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The PROGRAM FOR THE WINTER MEETINGS OF THE SOCIETY

THE Society meetings to be held in the next month or so will be characterized by an effort to carry out the prevailing spirit that meetings of national organizations must be of such a nature as to help in carrying out the war program of the Nation.

The Meetings Committee of the Society, which consists of David Beecroft, chairman; Leonard Kebler, Fred E. Moskovics, F. E. Place and George T. Strite, has accomplished this end in making arrangements for the Annual Meeting, which is to be held in New York Thursday, Jan. 10, this date having been designated as S. A. E. Day by the management of the New York Show.

During the day S. A. E. headquarters will be at the Engineering Societies' Building, 29 West Thirty-ninth Street, New York; a business session will be held Thursday morning and a professional session Thursday afternoon, while the final event of the day will be the Automotive Industries Dinner to be held at 7 p. m. at the Hotel Biltmore, New York. The capacity of the Biltmore is 1000, and applications have already been received for over 600 seats. Members desiring to attend the New York dinner should therefore send in at once $5 for each place they wish to reserve.

A meeting of the Standards Committee will be held Jan. 9, 10 a. m., at the Engineering Societies' Building for consideration of Division reports before their final submission to the Society meeting the next day. All members of the Society are invited to attend the Standards Committee meeting.

The business session on Thursday, Jan. 10, will convene at 10 a. m. Reports will be presented by the Treasurer of the Society, by several of the administrative committees, and by the Tellers appointed to count the votes cast for officers of the Society who will serve during the ensuing year. Addresses dealing with current Society activities will be made by the retiring and newly elected presidents of the Society. The Standards Committee will report on the work during the last six months. It is probable that several new amendments to the Constitution will be proposed for consideration.

The professional session will start promptly at 1:30 p. m. Thursday, and it is planned to serve a buffet luncheon at 12:30 in the hall adjoining the meeting auditorium, so that the members will not have to leave the building during the noon hour.

The professional session will be devoted exclusively to the consideration of subjects of the highest importance in carrying on the war. Major J. G. Vincent will give an address on The Reasons Behind the Liberty Airplane Engine, and it is expected that Colonel V. E. Clark, Capt. Howard Marmon and H. M. Crane will discuss the same subject.

A symposium on the reasons behind the war truck will be participated in by a number of the engineers who have been engaged in the actual design work. Capt. W. M. Britton will discuss the engine testing; A. S. Milbrath, the engine design; Cornelius T. Myers, the general chassis design; and A. W. Copland, the reason underlying the transmission designs.

It is also possible that important papers on fuels, pneumatic tires, and the general thermodynamics of internal-combustion engines will be included in the program.

The Annual Meeting will conclude with an Automotive Industries Dinner at which John Kendrick Bangs will serve as toastmaster. Gen. Chauncey B. Baker, U. S. A., and Gen. J. D. Cormac of the British War Mission in this country have consented to speak on transportation problems connected with the war. Tentative arrangements have also been made to secure other speakers of international prominence. The complete details will shortly be sent to the members.

The Meetings Committee this year has introduced an innovation in holding a Society meeting during the Chicago Show. This will consist of a professional session to be held Feb. 1 at 2 p. m. in the Crystal Room, Hotel Sherman, and a dinner to be held at 7 p. m. at the Hotel New Morrison. The banquet hall of the New Morrison has a capacity of 1900 and a war price of $3 per plate has been set. The members of the Society should make reservations at the earliest possible moment, because over 450 tickets have been sold to date.

A comprehensive program of tractor engineering papers has been planned for the Chicago professional session. Tractor fuels, tractor design, tractor-engine design, tractor-transmission design and the service requirements of the farmer will be discussed by well-known authorities. The points made in all these papers will be summarized by a tractor engineer connected with one of the large makers. His paper will thus serve as a broad discussion of the whole field of tractor engineering.

The war dinner to be held at the Chicago meeting will be one of the biggest affairs of this kind ever handled by the Society. Arrangements for the dinner are being made by committees from the membership of the Mid-West Section of the Society. It is expected that Secretary of War Newton B. Baker will appear as the chief speaker, and that other men of international fame will

also be on the program. Dr. Harry Pratt Judson, president of the University of Chicago, will serve as toastmaster. A patriotic musical program of unusual extent is being planned for the dinner. A large pipe organ will be installed in the New Morrison banquet hall especially for the occasion; four concert pianists will take part, as will also the Apollo Club of Chicago, assisted by several other prominent Chicago choral societies. All these will work together in rendering the national anthems of the twelve allied nations.

The Meetings Committee is also making plans for a marine session during the Motorboat Show. This will probably be held Friday, Jan. 25, with a technical session in the afternoon and a dinner in the evening. Invitations will be extended to engineers and executives connected with manufacturers of marine apparatus. Papers will be presented dealing with a number of different types of marine motive power. The members of the Marine Division of the Standards Committee will lead a discussion on the subject of standardizing marine parts.

Progress of AA War Truck Design

THE design of the Class AA truck, which will carry 1500-lb. pay-load, has practically been completed. This is one of the most interesting developments of the engineering work initiated by the Quartermaster Department, as a result of which complete designs have already been prepared for the Class A and Class B war trucks.

A notable feature about the AA truck is that it will be used by so many different departments of the Government. For instance, the Medical Corps will use the new design for ambulance service, the Quartermaster Corps will use it for certain forms of transport work, the Signal Corps for aviation service, while the Ordnance Department and the Engineer Corps of the Army will also make use of the new truck. The department requiring the truck for civilian service is the Post Office; the Navy and the Marine Corps will also require some of the trucks.

In settling upon the design it has been found possible to meet the requirements of all these different departments. While a few details remain, the principal design of the truck has been completed. The first engine has already been built and is now being tested in a factory in the Middle West. A production record was set in building this first engine. The drawings were handed the manufacturer at 6 p. m. on Nov. 26, and the engine was completely finished on Dec. 10, the total elapsed time being, therefore, only about fourteen days.

Engine Details

The Class AA truck is designed to operate at 30 m.p.h. on pneumatic tires. The engine has a 4-in. bore and 5-in. stroke, or 251.3 cu. in. displacement. The maximum torque obtained from this engine is about 1800 in-lb. At 30 m.p.h. with the rear-axle gear ratio of 5.5 the engine speed will be 1583 r.p.m.

Fuel will be supplied from an 8-gal. gasoline tank on the dash. A reserve tank will be installed under the driver's seat. The radiator is to be of the vertical tube type with a provision for attaching shutters. The cooling fan will be 16-in. diameter with a ball-bearing hub and the belt 1½ in. wide.

The crankcase is of aluminum with a No. 3 S. A. E. bell housing, supporting arms being placed at the rear and a trunnion at the front. It is planned to have a governor as optional equipment, but when used the construction will be the same as that designed for the Class A and B trucks. The engine will have two sets of sparkplugs; a magneto and a built-in distributor will be provided. The starting motor will be optional, and a method of mounting it easily will be provided. The generator will be the same as that designed for the Class A or B truck.

The transmission will be of the three-speed type with the control in the center of the truck. A gear-shifting lever will be mounted directly on the transmission cover. A brake lever will be mounted directly on the transmission cover. Provision will be made for a tire pump and speedometer mounting in the transmission case. The S. A. E. standard gear-shifting gate will be used.

The gear ratios follow: High, 1 to 1; intermediate, 1.76 to 1; low, 4.01 to 1; and reverse, 4.93 to 1.

A fabric-type universal joint will be used between the transmission and clutch, while the rear universal will be of the same type adopted for the Class A truck. The shaft center will be about 5 in. below the top of the 5-in. frame.

The front axle will be drop forged of I-beam section, 2½ in. deep, and will be of the Elliott type. Taper roller bearings will be used in the wheel hubs. The spring-clip bolts will be ⅝ in. The drag link will be of 1-in. tube with one spring in each end, the distance between spring centers being 28¼ in.

The rear axle will contain the spiral bevel-gear drive with 61 teeth in the ring gear and 11 in the pinion, thus giving a ratio of 5.5 to 1. The brake drums are 16-in. diameter, with external and internal bands 2½ in. wide, fitted to the rear wheels. The driving torque reaction will be taken through a torque rod. Radius rods also will be fitted. The axle housing will be of compressed steel sufficiently heavy to carry its load without truss-rods. Alloy-steel tubes will be inserted in the housing to carry the outer bearings. All the rear axle bearings will be of the taper roller type.

The front springs will be 38 in. long, 2 in. wide, with not less than nine leaves. The center-bolt on the front springs will be offset 1½ in. The rear springs will be 54 in. long and 2½ in. wide. The bolt will be placed in the center, and not less than nine leaves must be used.

Frame Dimensions

The frame is to be of pressed steel 4 15/16 in. deep and 1¾ in. wide, with stock 5/32 in. thick. The frame will have an outside width of 30 in., while its overall length will be about 179 in. The length of the frame back of the driver's seat will be 9½ ft. The distance from the dash to the front of the driver's seat will be 26 in. The height from the top of the frame to the ground will be 26 in., when 35-in. tires are used.

The wheelbase of the Class AA truck is 130 in., the gage 56 in., giving a turning radius of about 21½ ft. Pneumatic cord tires 35 by 5 in. will be carried on split

demountable rims. Wheels with twelve spokes will be used on both front and rear.

It is estimated that the chassis with all tanks filled will weigh 3100 lb.; the express body, 700 lb.; a driver and assistant, 300 lb.; this giving with the normal pay-load of 1500 lb., a total weight of 5600 lb.

When the truck is loaded the weight on the front will be about 2240 lb., and that on the rear 3360 lb. With the truck unloaded the weight on the front wheels will be about 2100 lb. and that on the rear wheels about 2000 lb.

The civilian engineer personnel handling the design of the Class AA truck is as follows:

General Committee—A. W. Frehse, H. T. Thomas and B. F. Wright.

Engine Committee—W. A. Frederick, A. F. Milbrath, Albert A. Lyman and Charles R. Short.

Transmission Committee—George C. Carhart, F. Engle, W. C. Lipe, J. M. Riorden, and S. O. White.

Steering-Gear Committee—W. N. Osborn.

Axle Committee—G. W. Carlson, R. E. Fries and A. W. Russel.

Work on Large Trucks

On account of the wide use to which the Class AA trucks will be put, the design has been carried along with unusual dispatch. The sample Class A truck has been practically completed, but the design of the detail parts has been held up to a certain extent in order to expedite the design of the AA truck. It is believed that the first sample of the AA trucks will be completed about the middle of January.

The testing work is being continued on the Class B truck, which is proving satisfactory in every way. Experiments are now being conducted to determine whether the differential should be omitted in favor of a solid rear axle.

Industrial Training for the War Emergency

IN the past few years so-called human engineers have been coming into prominence, these including engineers doing production work, employment managers, experts in industrial training, all of whom give their time to a great extent to the development of the efficiency of working people.

In the present emergency it is necessary to take some decided action to satisfy the needs of the industries for labor. The Council of National Defense has therefore established as part of the Committee on Labor of its Advisory Commission a Section on Industrial Training for the War Emergency. This section in its personnel is not unlike the state councils of defense. In it are represented employers, labor, and educational welfare. Branch committees composed of representatives of these three interests are established in all the great industrial districts throughout the country. About 200 representatives of the foremost manufacturing companies in the United States are taking active part in the work. Committees of the Section are now studying some of the new war industries from the blueprints to the last touch on the finished article.

A committee has been formed to study the essential principles of tool-making and of the training required for tool makers. It is believed that this study and a further division of labor will save the time of expert tool makers so that they can handle only the most difficult operations and less efficient persons can do much of the work after a brief intensive instruction. One company has assigned its leading expert to the work of the committee. This company wants to train 200 tool makers quickly, and plans to do this rather than take them away from its competitors.

The section has also other activities that are of the highest importance. It is believed that technical and vocational schools, some of which have been removed in their work from actual trade experiences, can be brought into touch with the present emergency. Other fields must be developed, and the work is such as to deserve the utmost cooperation from engineers of the country.

The cooperation of the members of the Society, in so far as they are expert in shop management and in production methods or in the general field of human engineering, is therefore earnestly besought by the section. Members interested should communicate with H. E. Miles, chairman of the section, at 506 Council of National Defense Building, Washington. Those who write will be put in touch with the branch committees near their place of residence to the end that each can cooperate in the way that he can most efficiently and conveniently.

In showing the importance of the work of the section it has been stated that our human resources, or the mental and physical powers of the working people, are estimated in terms of money at $200,000,000,000, or five times the value of all our other national resources combined. Nine-tenths of the power of our enemy has come from the development of this one resource. Efficiency in the worker and in leadership also has resulted from such development, because 65 per cent of the men in the foremost places in both technical and managerial fields in Germany were working boys at 14 but had industrial training in connection with their employment.

Many factories on essential productions are estimated by their owners as being 70 per cent efficient and some are even less. The training in production of the operative and in processes of production seems to be the only way out. It is said to be impossible for us to produce enough or quickly enough until the skies of Germany are blackened by our airplanes and shells rain like water, all production being in proportion. Until this is accomplished we have not done enough.

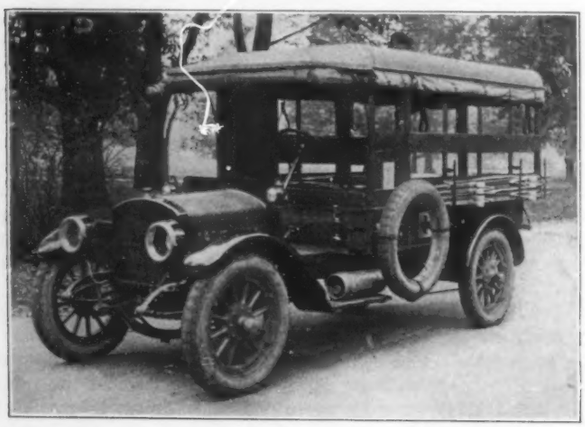
The program proposed by the section is essential to the accomplishment of our war purposes. The largest corporations in the country have already adopted the same sort of effort in connection with their own interests. According to the Department of Labor, 1,500,000 workers must be trained over into war and other national industries, so that while the question of over-supply or under-supply of labor may be open to discussion, the need of the training of countless workers is unquestionable.

Ambulance Engineering Work

SINCE the Medical Corps of the Army will undoubtedly be one of the largest users of the Class AA truck, it will be of interest to consider the progress already made in designing ambulances. The technical work of the Medical Corps is handled by a part of the National Army known as the Sanitary Corps. To this latter corps are attached all the engineers required for the needs of the Medical department. A large number of members of the Society have gone into this particular service and as a result full advantage has been taken of the facilities for cooperation provided by the existing S. A. E. organization.

The Medical Corps, in fact, early recognized the need for experienced automobile engineers to handle the design of ambulances. As a result a complete organization has been built up and is at present engaged in the design, production, inspection, assembling, both in this country and overseas, and finally in the upkeep of the ambulances that will be required by the United States Army. It is expected that the major repairs on these ambulances will be made in the Quartermaster Corps repair shops established at suitable locations back of the lines, but the preliminary work will be done by an organization created by the Medical Corps.

Several thousand ambulances have already been ordered, these being ¾-ton capacity, equipped with four-cylinder engines, and three-speed and reverse transmissions. The rear axle is of the full-floating type, with a spiral bevel-gear rear-axle. These ambulances, which are shown in the accompanying photographs, are equipped with pneumatic tires and with a special spring suspension



MEDICAL CORPS AMBULANCE WITH BODY OPEN

designed by the Sanitary Corps engineers. Standard bodies of both ambulance and spare-parts trucks are also being produced in several plants throughout the country.

Among the important results already obtained in the ambulance design has been an enclosed body with a special litter-loading trolley, this being arranged to carry four prone or eight sitting wounded men. A new spring design has been developed and will, it is expected, give remarkably improved riding qualities. This is an important point inasmuch as the very lives of wounded men depend on the riding conditions involved in their transport. An improved driver's apron and enclosing curtain have been designed, a heater installed in the ambulance, and finally, this being exceedingly important in view of our limited shipping facilities, an ingenious method of

ARMY AMBULANCE WITH CURTAINS DOWN

knocking down bodies and chassis for overseas shipment has been devised.

In order to handle the work connected with the production and inspection of the ambulances a complete corps of automobile men, with a commanding officer, has been placed at each plant where chassis or bodies are being built. A complete base organization will be needed for overseas work. At Washington a corps of officers and non-commissioned men are on duty at a motor ambulance station, which is especially arranged for testing new designs and equipment and for the continuous testing of standard ambulances.

In view of the necessity of having standard equipment to take care of the spare parts and other problems, it is impossible to accept the ambulances of widely varying types of construction that are continually being offered to the Government by patriotic organizations throughout the country. It is said that the Medical Corps has been deluged with such offers and that finally it has been forced to refuse all such vehicles unless they are standard equipment. The patriotic spirit of those making such gifts is recognized, and the means, therefore, have been provided so that they can purchase standard equipment and give it to the Government.

Another instance of patriotic devotion, this applying particularly to the engineers experienced in ambulance body and chassis design, is the way in which the Medical Corps has been able to call such men into conferences and to obtain the most expert advice in regard to the various problems encountered. It is understood that practically this whole problem of motor ambulances is being solved by members of the Society either commissioned in the Sanitary Corps or called upon for advice as needed. The Medical Corps has shown due appreciation of the value of such work, which will increase immensely the assistance possible to give wounded men belonging to the United States Army.

Problems In Airplane Production

By Dr. W. F. Durand*

WHEN hostilities were declared last April, no one connected with the Government had any idea of the part that the air service was destined to play in the war. It was not until the visits of the Balfour and Viviani-Joffre Missions to this country that the plans began to take a definite form.

Immediately there arose a series of the most important problems which have been presented to the United States and to her engineers in an engineering and industrial way. The following constitute certain of the more important problems:

(1) What number of machines for active service at one time shall be set as a goal?

(2) What wastage is to be anticipated in such machines?

(3) In consequence, what number of each type must we be prepared to build within a specified time?

(4) How many trained aviators will be required to maintain the desired number of machines in active service?

(5) How many men must be put through preliminary training to secure the necessary number of active aviators with the requisite reserve; or, in other words, how much raw material must be handled in order to secure the necessary amount of finished product?

(6) How many mechanics and repairmen will be needed to keep this fleet of airplanes ready for instant service at any and all times?

(7) Where and how are we to undertake to build the number of airplanes necessary in order to maintain the fleet continuously at proper strength? Or, stated otherwise, what is the maximum number of airplanes of the various types that can be built by the United States without undue disarrangement of needful war industries and of the irreducible minimum of peace industries?

(8) What will be the extent of the demands of our allies in Europe for airplanes or types of engines that we may hope to produce with high economic efficiency on our air productive capacity? And to what extent can we expect to draw upon them for certain types?

(9) To what extent will our allies call for raw material, such as airplane timber? Will the total demand exceed the supply; and if so, to what substitutes can we turn?

These were some of the questions that arose immediately and which pressed for immediate consideration and answer. I shall indicate in broad terms the general character of the answers to some of these problems.

Number of Airplanes

There is no use of our talking about an air service if the number of airplanes is to be limited to a few hundreds. If we have any vision of the activity and efficiency of air service as now conceived, it must mean the production and operation of airplanes in numbers measured in units of thousands, and not hundreds. We must, therefore, fix as a number, in order that it may have any significance in the problem, a number measured in thousands. If we can say five thousand, it is well. If we could say more it is better. There is no definite answer to the first question, but we are committed to maintain airplanes, once we are under way, in many, many thousands.

What wastage is to be expected in such machines?

This is a matter of statistics, and the data for the accurate determination of the answer to this question are not available. We lack definite information as to the average life of a machine. Under certain conditions it may continue in active service a month, a week, or perhaps only a day. But machines do not fly every day; conditions of weather intervene and only a fraction of the 365 days of the year will be available for the operation of fighting machines on the front. The approximate effective life of the machine will be several weeks, possibly three or four months.

The third question is tied up with the number to be built, and the answer is the same. We must be prepared to build airplanes in thousands. We must be prepared to build a multiple of any number in service at any one time. If we are to maintain 5000 airplanes in active service at one time we must be prepared to supply during the specified time a multiple of three, or four, or five, or six times that number. We must be prepared to face a productive program of that order.

With modern machines, carrying more than one man, we must maintain in active service more than one man in each machine. There has been a tendency not always to insist upon every man who goes up being required to handle the machine. A man may be a good observer without being a good pilot. But this is not ideal. We think no man should go up for any purpose without being able to pilot the machine in case the regular pilot is injured or killed, and to bring the machine back within our own lines. This means there must be a number of men with a given minimum of skill trained for auxiliary service. The number of men we must be able to turn out in the course of twelve months must be measured in units of several thousands. Five thousand should be the minimum, and we must look toward a multiple of such a number.

Training Aviators

The first step in training an aviator is to give a brief course of eight weeks at the so-called ground school. It is a school intended for preliminary instruction, not including work in the air. It includes elementary instructions in the principles of flight, in the principles and operation of internal-combustion engines, photography, scouting, machine-gun work, and comprises lectures, class work and laboratory exercises in these subjects. That course runs for eight weeks.

The course contemplates the entrance at these institutions of twenty-five candidates per week, and the graduation each week of whatever is left of the twenty-five. Without wastage, twenty-five per week would pass from each school to the flying schools; and with eight schools there would be about two hundred cadets a week, or about ten thousand per year.

There would be necessarily a considerable wastage, and perhaps not more than one-half of that number would realize an efficiency that would make them effective units in the program as time goes on.

*Chairman, National Advisory Committee for Aeronautics.

From address delivered at the Annual meeting of the A. S. M. E.

The capacity of these schools could be multiplied, and such multiplication is now being developed. There need be no ground of apprehension about training these men, assuming that we get young men with the necessary personal, physical and mental characteristics.

It is true that the number of men is small whose nerves and muscular reactions are such as to make them react instinctively—bird men. Every well-built normally developed and endowed young man can develop, however, a degree of skill sufficient to render him an effective unit in one place or another in the air service, but only a few reach the supreme excellence which we see in some of the specially trained airplane fighters.

The number of mechanics and repairmen is a matter of experience. It is found that one specially skilled mechanician must give his entire time to the maintenance of each particular machine; and for each group of twelve, twenty-four or thirty-six airplanes there must be an additional number, and in the base supply depots and other points back of the line there must be others.

If we go back to the supply of gasoline and lubricating oil, and to the supply of elements of that character, we greatly multiply the number of men necessary to maintain in a state of efficiency any one airplane; but stopping short with the number of men concerned with the aircraft itself, we must multiply the number of aircraft by three, four or five.

If we should take into account the number of fliers contemplated and the number of mechanics and repairmen behind the line in one capacity or another, it results in a contemplated personnel for the Signal Corps exceeding in numbers the entire standing army at the outbreak of the war.

Developing an Industry

Where and how are we to undertake to build the number of airplanes necessary in order to maintain the fleet continuously at proper strength? This question comes home closely to engineers and men concerned with the industrial development of our country. It has been necessary to develop an industry highly trained and highly specialized, from a very small beginning.

Fortunately the material for such expansion was found in the shops, trained personnel, the equipment and the organization of the automobile industry.

A few weeks ago I inspected three centers of airplane production—Dayton, Detroit, and Buffalo. There we saw new factories, either completed or on the point of occupancy, aggregating something like thirty-five to forty acres of ground area, to say nothing of the gallery space.

Furthermore, there was ready for immediate expansion perhaps twenty-five to forty per cent more space. Early in the next year there will be occupied actively in the production of airplanes something like fifty acres of ground area that did not exist eight months ago. This is without taking into consideration the automobile factories, acres upon acres of which are making solely airplanes and airplane parts.

The period that has elapsed since last June or July, when the present program began to crystallize into reasonably definite form, has been necessarily spent in measures to prepare for this tremendous program of expansion and industrial development. We can certainly anticipate within two or three months that our air-factory capacity will be occupied in turning out airplanes at the rate of several thousand per month.

The demands of the Allies will put to the test every bit of our productive capacity for airplane material. We are now making for them flying-boats in large numbers, and they are looking more and more to us for the production of the simple training machines. The American type, for at least the American and Canadian and British services, is the nearest approach to the standardization of a definite type, and they will look to us for other types and for the production of airplane engines.

The demands for supplies are at the limit of our productive capacity. The demand for spruce has been incessant. Serious difficulties have been found on the Pacific Coast in the way of supply. Substitution of other goods has been thought of, which have different characteristics, yet give effective service. Metal substitutes seem to hold hopeful and interesting possibilities.

Standardization of Elements

The question of standardization, the standardization of elements and types, has presented itself again and again, and aside from the questions of policy or program it is one vital to the engineer.

The standardization of elements, such as screw-thread and fastenings, has progressed satisfactorily through the efforts made by the SOCIETY OF AUTOMOTIVE ENGINEERS. There is soon to be held in London an International Standardization Congress at which we may anticipate a still further approach toward standardization by way of elements and parts. Obviously the more we can do along such lines the more effective will our efforts become.

The other problem is to standardize a type, but herein lies danger. It is necessary to standardize; but it is fatal to attempt to standardize a type too rigidly. Experience on the Western front shows that a type has no longer begun to prove measurably successful than it is out of date by the appearance of a new and improved type.

The entire program must be based on the expectation of displacing from time to time types that we may for the time being standardize for production purposes but which we cannot continue to produce by reason of the development of other and more efficient types.

I have tried to visualize a tremendous stream of production. Parallel with this we must have development, research, investigation and a program that is seeking contact with the unknown and the new; developing, judging, testing, and determining their technical characteristics and their adaptation to the conditions of active service. As fast as new types and forms are developed and proved superior, just so fast must they be placed in production, taking the place of out-of-date forms. Only in this way can we maintain the types and forms in use at the front and be responsive to the advance in science and art of airplane production. The conditions at the front must determine the characteristics of the material to be supplied for our services there.

Some Special Problems

If we have the same engine working at sea-level and then soaring upward, the power diminishes with the rarity of the high-altitude atmosphere. One problem is supercharging the airplane engine so that it will maintain the power at high altitudes, and not suffer the loss normally attendant upon working in a rarefied atmosphere. Many devices have been suggested, but the problem is doing it in the most effective way. If we solve that we will make secure for a long period our supremacy in high-altitude service.

Another development is that of modifying at will the pitch of the airplane propeller. It is of small use to main-

tain power if the propeller is to maintain the same pitch in an atmosphere of reduced density. The engine will speed beyond the limit or the rotation speed of the engine will limit the power developed. Some way is therefore required for modifying properly the pitch of the propeller, in order that we can, without undue sacrifice of efficiency, cause the rotative resistance of the propeller in a rarefied atmosphere to correspond in some degree to the continuing torque of the engine.

Another problem is that of the spark-plug. The modern spark-plug has been a development in response to the compression pressures prevailing in automobile practice. It is found, in the higher pressures in aeronautic service, that such spark-plugs rapidly break down. The insulating characteristics are soon lost, and there is a bewildering uncertainty as to the life of the spark-plug under present conditions.

Throughout the recent trip of inspection we were impressed with the serious purposes with which the captains of industry in this field of production are approaching the problem. They realize its magnitude and its importance, and they are approaching it with high purpose and patriotism. With the presence of such a pervading spirit in the industries of this country, we will make good with regard to our program of airplane production. Not quite what was hoped, perhaps, in the first flush of anticipation, but the production of airplanes will not be our least contribution in settling this world war.

Solving the Gasoline Problem

By W. P. Deppé (*Ass. Mem. S. A. E.*)

Metropolitan Section Paper *Illustrated with* Charts

THE operation of internal combustion engines with superheated homogeneous fixed dry gaseous mixtures below combustion temperatures, before spark ignition, and prepared before entering combustion chambers, is one of the most radical improvements since the four-stroke cycle was announced in 1862 by Beau de Rocha.

By using exhaust gas to fix mixture temperatures, with correct mechanical means to produce instantaneous and complete diffusion, with proper proportions of means employed, liquid hydrocarbons vaporizing below 600 deg. fahr. and air can be automatically integrated as a fixed gas at all engine speeds. The parts of the crude vaporizing above 600 deg. fahr. are best fitted for lubricating oils, and are now required for lubricants if we are to have more fuels. Automatic control of temperature, pressure and time limits can be secured at each throttle opening, regardless of the variations seriously affecting the wet-mixture methods of carburetion now in general use on power vehicles.

Superheated dry gas has all the desirable advantages of low-volatile true gasolines, and gives better power and fuel economy, even with fuels impossible to utilize by wet-mixture methods in throttle-controlled engines.

Some Properties of Water

Before proceeding further it seems advisable to point out a few commonly known properties of water in order to bring out clearly certain facts regarding petroleum. As a solid, water is in the form of ice at temperatures below 32 deg. fahr. Normally, as a liquid it exists at temperatures between 32 deg. and 212 deg. fahr.

Below the boiling point, at atmospheric pressure and temperature, water can exist as a spray, seen at Niagara Falls; as a heavy fog, occasionally seen at sea; and as a very light, although impenetrable fog, which one frequently meets with in mountainous country.

Above the boiling point, water can exist as wet steam, a vapor; or when superheated, as a true gas. The boiling point of water becomes lower as the pressure is decreased at altitudes or in a vacuum. Conversely, the boiling point is raised as pressure is applied.

Regardless of the amount of heat applied to ice, water, spray, fog, vapor, gas, and then superheated gas, the distinct time limits involved in the transformation from one state to another must always be considered. Water in any form is what one could designate a homogeneous mixture.

Alcohol is a liquid closely resembling water in all its properties, except that the chemical reaction or combustion when mixed with air can be of an explosive nature.

Normally, molasses exists as a sticky thick liquid, or as thin liquid when heat is applied. It will partly vaporize, and also will produce sugar. Its viscosity varies with the temperature. If the temperature applied is too high the molasses may be scorched.

In dealing with mineral oils, one has to contend with all the properties found in water, alcohol and molasses, and, in addition, with more formidable ones; for example, varying viscosity as liquids, great differences in specific gravity and boiling points, liability of cracking, and gas dissociation. Fuel oils to which the same amount of heat has been applied can exist below the combustion point in carburetion devices in all the states common to water, from liquids to superheated gas. With wet-mixture methods of using engine cylinders as vaporizers, the true gases of mineral oils do not become superheated, homogeneous, fixed dry gases, such as superheated steam, until after ignition, unless in addition to vacuum and heat, mechanical means are used below ignition temperatures to hasten complete diffusion.

Making More of the Crude Useful

If a method of engine design, or an improvement in carburetion can be suggested, so that kerosene can be mixed with gasoline and operation secured like that with true gasoline, it means in effect ultimately doubling the engine fuel without increasing the production of crude oils or seriously altering existing oil refineries. It would make available an increased gasoline production of 55,000,000 bbl. per year.

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Or if a method of engine design or an improvement in carburetion results in increasing by 50 per cent the mileage per gallon secured with commercial trucks and passenger cars, the ultimate result on the so-called gasoline shortage is in effect as if new oil wells producing 50 per cent more crude were discovered. Another 55,000,000 bbl. of fuel would thus be made available.

Let us suppose that such methods are commercially developed, and that all new cars, trucks, tractors, and even airplanes, are equipped to handle not only a mixture of half kerosene and half gasoline, but also with the same operating ability as they do true gasolines, a low-grade fuel oil consisting of from 40 to 50 per cent of all the crude; assuming also that in five years all existing vehicles will be worn out, or cannot be operated on such low-grade fuels, and are replaced by better engines and vehicles; then, with the cracking methods suggested by the Bureau of Mines, oil refiners could almost triple the production of fuel for motor vehicles. More than 200,000,000 bbl. per year of fuel acting like true gasoline could be used.

These suggestions are in line with the recommendations of the Bureau of Mines, that more of the crude should be more refined, and that the refined oils should be better utilized.

In order to improve the farm tractor, commercial truck, passenger car, or airplane, we must first study mineral oils, or liquids secured from the distillation of coal and alcohol, however produced, because without the hydrocarbons, the mechanisms are useless. Engines now must be built to handle possible fuel, not fuel made for endless variations in engines and carburetion limits. So why talk about substitutes for mineral oils before we perfect means of utilizing them?

The sole purpose of this paper is to state in non-technical terms the different methods in refining oils handled by distillation plants as liquids, vapors, dry gases, or gases in a superheated state above the combustion limits of fluids in which factors of engine design limit refinery production capacity; likewise, the difference between breaking down crude oil by so-called cracking methods and what appears to be the same problem reversed in handling refined oils and air as a fuel mixture for the present-day types of internal combustion engines.

Economic Forces Involved

It is impossible in a paper of this character to do more than touch upon the fundamentals involved in the scientific and economic problems now confronting oil refiners, carbureter makers, engine designers, and the general public. It seems necessary, however, to call attention to the economic forces involved, these embracing crude-oil production, its refining, and its use when mixed with air as a fuel for internal combustion engines. These engines are now operated by more than 5,000,000 owners, and perhaps as many more in work connected with the machines. Four-stroke cycle, throttle-controlled, internal combustion engines now comprise about two-thirds of all the prime movers in the world.

The Allied nations will have about 30,000 airplanes, each of 200 hp. or more, in service within a year; these will use 20 gal. per hour of high-grade gasoline if they actually deliver anything like their power ratings. At an average of only five hours' service per day, here is an additional daily demand next year of 70,000 bbl. of good gasoline, or an increase of over 30 per cent, to say nothing of the requirements of more than 50,000 military trucks and a million commercial cars, trucks and tractors, if we produce what we simply must have, to hold our own in the war. Two-thirds of all passenger cars, trucks and tractors are necessary both for military and civilian transportation purposes. We cannot make horses do the work, because we are already short through their military destruction.

Present Supply of Coal Adequate

We now must define the true field for coal and oil as fuels. We also have to consider it as a world problem. Roughly, about 1,000,000,000 tons of coal are required each year for the steam engines and furnaces of the world. Coal is found in about thirty-eight States of the Union, and exists in almost all parts of the world. Its supply is unlimited so far as the needs of this generation go, so that the author believes nations should consider seriously the passage of laws prohibiting the use of mineral oils for producing heat when coal could do it practically as well.

The average consumption of oil burned under steam-boiler plants is around one pound per horsepower per hour, while gas engines should require less than one-half that amount.

Supply of Mineral Oils Limited

The annual production of crude oils in the world at present is something less than 500,000,000 bbl., of which 310,000,000 come from this country. The total consumption of crude oils is apparently 50,000,000 bbl. per year greater than the total production of crude oil in fields now in commercial contact with the civilized world. This in spite of the fact that passenger-vehicle use is prohibited everywhere except in North America.

Oil must be where we can use it before it will help to solve our daily transportation problems. It will cost vast sums, and will take some years to produce ships, pipe lines, and to make refinery improvements so that more than 10 per cent of the Mexican crudes can be used for so-called gasolines.

All nations have reached the point where more crude oils must be produced from existing or possibly from new fields; more than the 18 per cent of desirable refined oils now obtained must be produced from the crudes, and more useful work must be had from each pound of fuel oil in internal combustion engines.

Securing Better Performance

All cars now average less than 12 miles per gallon of gasoline. This average can be made nearer 18 or 20 miles per gallon by better carburetion means, using half-gasoline half-kerosene mixtures, distillates, or low-grade fuels.

Likewise, trucks average from 4 to 5 miles per gallon, and can be made to go 6 to 8 miles. Tractors using 3 to 4 gal. per hour can be made to run on 2 to 2½ gal. per hour. In England a one-plow tractor on which great hopes were based recently in an hour's test in hard ground required 5 gal. of fuel per acre, which is a prohibitive consumption.

Four-stroke cycle stationary engines can be made to show Diesel-engine fuel economy using kerosenes and distillates. Four-stroke cycle engines cost from $10 to $15 per horsepower, and Diesel engines from $50 to $75 per horsepower.

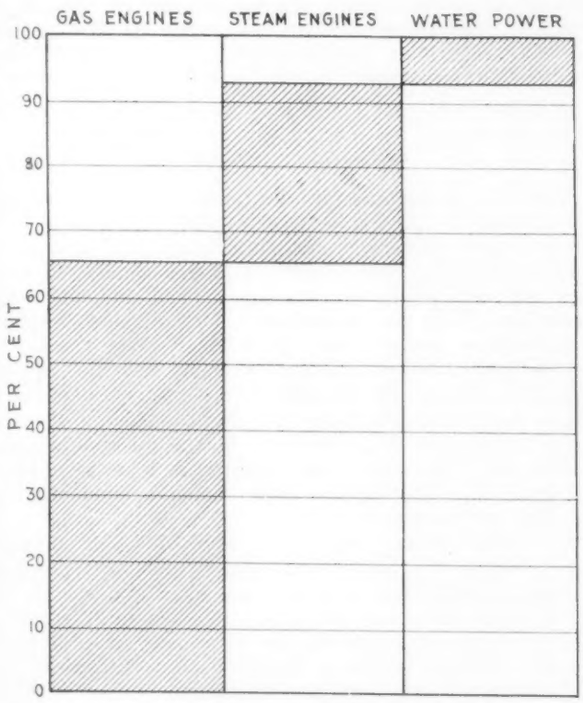
Examples of Economic Mistakes

To the author, the use of mechanisms in automotive apparatus that limit the oil refiner so that less than 18 per cent of the total crude-oil production in the world

is turned into commercial gasoline seems an economic wrong of the first magnitude. The refiner is limited only by carburetion methods now in use, his refinery capacity being ahead of demands for crude production.

The prices oil refiners establish for so-called gasoline are such as to produce most if not all of their earnings. A large part of the 82 per cent of crude oils is sold for less than the cost of raw materials and overhead charges. This seems an economic wrong, which must ultimately be corrected.

American oil refiners export gasoline and naphtha that permit the best brand of English gasoline, for instance, to have an initial boiling point of 120 deg. fahr., and an end point of 250 deg.; most of the liquid has a boiling point below that of water. Another well-known brand of gasoline in England has an initial boiling point of 126 and an end point of 290 deg. The worst grade



Comparative Relation Between Gas Engine, Steam Engine and Water Power in Use

of gasoline now available in England has an initial boiling point of around 180 deg. and an end point under 360 deg.

All of the English gasolines are much better from a carbureting standpoint than anything now sold in large quantities in America. One frequently hears American engineers boasting of following the latest European engine practice without realizing that the gasoline now sold in Europe is something like that used from 1900 to 1907 in this country.

Sooner or later, the absolute necessity of producing more gasoline for American consumption will compel oil refiners to use here most of the gasolines and naphthas now exported to "sweeten" the low-grade fuels. All the world must be satisfied in due time if it gets a supply of fuel as good as the average in America. This means that European engine design must follow American design in the future, rather than that American designs will be based on European practice, as in the past.

Fortunately, however, by the use of cracking methods for distillation, the refiners can produce engine fuels from a greatly increased percentage of the total crude oil, whenever proper engines and carburetion methods are provided.

The author does not believe that any engineer in the Society will contend seriously that oil refiners should be compelled to produce one grade of gasoline for airplanes, another for trucks, tractors, and passenger cars, and still another grade for marine and stationary engines. All engines can be made to use a single standardized low-grade fuel, say one of which about 5 per cent, instead of the 20 per cent fixed by the Detroit gasoline ordinance, would boil below 220 deg. fahr. The Government has suggested limiting the end points on the other end of the scale, thus simply "hobble-skirting" the oil refiner.

Again we say, engines in future must be built with reference to the character of the fuel oils available and from the standpoint of the oil refiner.

Up to within the last year or two, owing to the lavish volume of crude oil as compared to the volume of refined oils demanded, it was not really necessary for any one to design gas engines to secure more useful work per pound of fuel. The situation now, however, is completely reversed, and military and economic forces demand immediate action.

Cracking Methods in Use

Before we can suggest improvements in engines and in oils and oil refining, we must consider some things not clearly brought out, as a rule.

Oil refiners can now use in large commercial operations the following general methods whereby the production of so-called gasoline can be increased:

(1) Cracking oils as liquids with heat and pressure.

(2) Cracking oils in vapor state with heat and pressure.

(3) Cracking oils by the addition of steam or hydrogen, in both the liquid and vapor states, with heat and pressure.

(4) Cracking oils in the superheated gas state by adding steam and using pressure and temperature, thus causing partial combustion in the distilling plant.

Most of these methods of cracking oils seem to cause condensation of the refined liquid oils under pressure, although some methods seem to cause condensation after release of pressure.

The application of heat and pressure to mineral oils in the refinery, either as liquids, vapors or gases, is deliberately done with the idea of splitting up heavier hydrocarbons into lighter hydrocarbons; in other words, of cracking or breaking down the natural constituents of the molecules as nature presents them in the crude oils. Liquids which do not burn at any time are thus produced, as is also vapor, or even dry gases, below the ignition temperatures.

Carburetion Reverse of Cracking Action

In an engine, the reverse of the cracking process is necessary. A gas must be produced before combustion takes place, if maximum power, flexibility and Diesel-engine fuel economy are desired in throttle-controlled four-stroke cycle engines.

The oil refiner can have conditions fixed and arbitrarily controlled so as to give the desired pressure, temperature and time limits in order to break down the crude oils into refined oils and by-products. He can have tubes from 10 to 300 ft. in length to fix his time limits.

In a gas engine there is now no fixed control of pressure, temperature, and time limits. The mixture must be handled in a partial vacuum varying from slightly less than atmospheric pressure to as much as 25 in. Hg., according to the throttle opening, speed and type of engine, and then the problem of compression pressure enters. The increase in pressure raises the boiling points of oils at a time when it is all important to hold the mixture in a dry gas state. Compression pressures vary with throttle openings also.

Dry Gas Essential

The object of carbureting oils and air should be to produce not merely an atomized or foggy state of the oil in the air, not merely a vapor state of the fuel oil in air, but instead a dry gas mixed with superheated air at less than atmospheric pressure. At the end of the intake stroke, the pressure increases just as in the case of the oil refiners' stills; except that this pressure is not fixed, but increases during the compression stroke until dead-center position is reached, when the electric spark is supposed to ignite the mixture.

This compressed mixture must not be stratified, but must have some of the lighter hydrocarbons mixed with the medium hydrocarbons, and both mixed with some of the heavier hydrocarbons, and all of these mixed in air in such a way that each hydrocarbon molecule is in physical contact with oxygen. No combustion in any combination of gases can be maintained without the presence of oxygen, properly diffused, and brought to the firing temperature.

Nitrogen, a non-combustible gas, forms about 80 per cent of the air, and oxygen about 20 per cent of air, and by volume, air represents about 10,000 parts to one part of liquid oil in the mixture, so that it is readily seen how difficult it is actually to produce and hold superheated homogeneous fixed dry gas before ignition of the mixture takes place. Certainly this is not the state of the average mixture, as made by any wet-mixture carbureting system yet devised for general commercial use.

Initial Flame Propagation Vital

Fuel oil is wasted if the gas in the cylinder, at the end of the compression stroke, is in any other than a superheated homogeneous fixed dry state, because the initial flame spread at that time is what seems to furnish the greatest energy to the piston. The 3000 or more patents in the world covering what are known as carbureters, or metering devices for air and oil or for other liquids containing hydrocarbons, indicate lack of appreciation of what is involved in the carburetion of oils and air.

Any ordinary carbureter, through which one passes common coal gas or natural gas mixed with air in any proportion, to give combustion, is a gas carbureter, but is not a superheated dry gas carbureter. If the same carbureter uses 88-deg. gasoline, it will become a vaporizer, and if sufficient heat is added in the proper way it might be called a dry-gas carbureter. If the same carbureter is used for metering present-day commercial gasoline, which contains some true gasoline, some naphtha, some benzine, and perhaps a slight amount of distillates with boiling points higher than benzine, it becomes simply a meter of oils and air, and is, in fact, a wet-mixture carbureter, because the mixture at the beginning of the intake stroke of a gas engine is not dry gas. It is the opinion of the author, that with from 70 to 80 per cent of present-day gasolines at the beginning of the intake stroke the mixture is in an atomized liquid state containing some vapor, but little dry gas.

The heat of compression perhaps does produce some dry gas, some vapor, in a more or less stratified state, to the limits of saturation of the air contents in the mixture. Some liquid precipitates with heavy hydrocarbons, owing to pressure raising the boiling points above existing temperatures. The superheated homogeneous fixed dry state does not ensue until the electric spark has made and ignited the gas in that state around the flame area. Once combustion starts, the heat of the flaming mixture produces swifter gasification in the cylinders and greater spread of flame as the piston descends.

It is the author's opinion, however, that in most engines a small part of the mixture actually furnishes the useful work, because the piston frequently travels faster than the flame spreads; also expanding gases are exceedingly difficult in which to maintain a fixed temperature, let alone an increasing temperature. The mere expansion of the air and the evaporation of oils therein absorbs heat energy. With wet mixtures this happens in the carbureter, intake passages, and in the intake stroke in the cylinder, as well as during vaporization in the compression stroke, to a degree which is but little understood.

Ineffective Gas Producers

Men can devise gas producers in which intense heat is applied to the liquid mineral oils or in which the temperatures are high enough to cause partial combustion so that superheated dry gases are made; but these are not necessarily homogeneous, fixed and dry when transferred into the intake manifold, the valve chambers, or even into the cylinders themselves. Men are baffled by the loss of power, low fuel economy and the lubricating-oil dilution, and perhaps do not realize that during expansion the cylinder acts like the condensing chamber used in the cracking processes of the oil refiners, also that under certain conditions the pressure of compression raises the boiling points and causes precipitation of heavier hydrocarbons.

The time during which air and oil move between carbureter and cylinder is so short, that it is not easy to make superheated homogeneous fixed dry gas in any device that will allow the mixture to maintain itself as a superheated dry gas to the beginning of the intake stroke. This is essential, however, for otherwise heat will be wasted on the compression stroke in merely partly vaporizing the mixture of liquid fuel and lubricating oil, as now is the case with present wet-mixture carburetion methods and present-day commercial gasolines with their low volatility and large proportion of heavy hydrocarbons.

Further, when heat alone is used during the short time present in high-speed engines, temperatures improperly applied, if high enough to make kerosene and air into a superheated homogeneous fixed dry gas before actual combustion takes place in the cylinder, are destructive to the molecules in the lighter hydrocarbons of gasoline, naphtha, and perhaps of the lighter benzine.

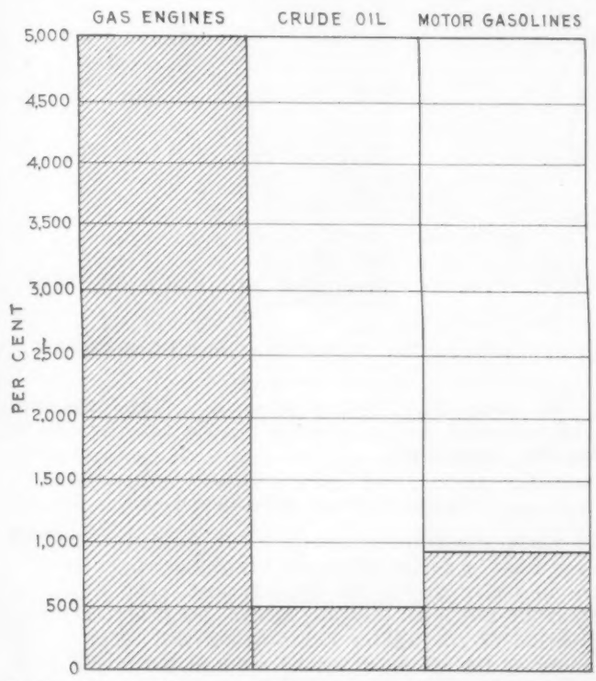
Engineers have been somewhat misled by the fact that gasolines of 15 to 20 years ago were a by-product of refineries chiefly engaged in producing illuminating oils and lubricants, and would readily evaporate within the pressure, temperature, and time limits existing in metal walls in carbureters, cored intake passages, and cylinders of a water-cooled engine, always below 200 deg. fahr. They had to act practically the same as the dry coal gases used abroad, in the development of what we know as the internal combustion engine, even though no at-

tempt was made to fix temperature, pressure, and time limits with the latter.

It seems to the author that engines designed as dry-gas engines are being operated with present-day gasoline as semi-Diesel engines. Not having the advantage of the high compression of the Diesel-type engine, which has pressure, temperature, and time limits fixed, the fuel economy possible with the Diesel engine is not obtained in the present low-compression engines that use commercial gasolines by means of wet-mixture carbureters.

Gas Producers Independent of Cylinders

Gas engines should be designed with a leaning toward the gun-powder theory of high force being developed initially at dead-center piston position, or at the moment of highest compression, instead of the attempt being made to follow the practice of expansion as typified by the Diesel and semi-Diesel types of engine. Diesel engines apparently do their best work when the engine speeds



INCREASE IN GAS ENGINES COMPARED WITH THAT OF CRUDE OIL AND GASOLINE PRODUCTION

are relatively low in comparison with those of the engines used in present-day power vehicles.

Superheated homogeneous fixed dry gases made in devices entirely independent of the cylinders for any of their vaporizing functions apparently permit what is the closest to gun-powder action to be produced in the gas engine. Their use also makes low-grade oils act like true gasoline, and gives maximum power and fuel economy. Cylinder temperatures should be as low as possible so as to protect lubrication functions, instead of as high as possible to act as crude vaporizers of present-day oils. With wet-mixture methods, temperatures at the center of piston tops from 800 deg. to 1300 or 1400 deg. fahr. are what result in pounding in the cylinders. No lubricating oil made can withstand such heat without vaporizing or cracking.

Unjust Prejudice Against Hot Mixtures

There is a prevailing impression that, if high mixture-temperatures are used, engines lose power because of loss of volumetric efficiency. But with heat correctly applied, homogeneity and dryness of mixture before ignition, completeness of combustion at or near dead-center piston position and at moments of highest compression; ability to use somewhat higher compression pressures in leaner superheated mixtures; all these more than compensate for any loss of volumetric efficiency obtained with the cooler wet mixtures. Diesel-engine fuel economy is thus possible in low-compression four-stroke cycle engines, in spite of high piston speeds.

Definition of Wet Mixtures

The author means by wet mixture, one that is not a true dry gas at the beginning of the intake stroke and that involves the use of cylinders as vaporizers to produce superheated homogeneous fixed dry gas in the flame spread after ignition. The time necessary for complete diffusion of gases before ignition affects power development more than is generally realized. One part by volume of methane or ordinary natural gas at atmospheric temperature and pressure mixed with one part of air, requires about 5 sec. for complete diffusion, without mechanical means to hasten it. It takes more than twice as long with five parts of air. These are relatively dry gases to begin with, but suppose we consider the time required to turn oils in a gas engine into fog, vapor, and dry gas when mixed with from 8 to 15 parts of air before ignition, with no attempt to control pressure, temperature or time limits, or to provide mechanical means to induce instantaneous results. It varies from 1/10 to 1/100 of a second, and diffusion is really completed only after the flame spread starts. But the piston is causing expansion of the mixture, and the flame works against that force, instead of raising the initial pressure, which is what produces useful power to the limit possible at dead center. Heat is lost to the cooling jacket, and the useful work output is small compared to the heat energy available.

The present-day high-speed, multi-cylinder, low-compression, four-stroke cycle engine, throttled-controlled, is used in probably 95 per cent of all installations in which the fuel is the refined mineral oil known as commercial gasoline. Therefore decided improvements in the methods of carbureting mineral oil and in engine design, all of which will allow more of the crude oil to be made into commercial gasoline, are desirable, unless existing oil refineries, motor vehicles and accessories are radically changed.

Existing Engines Not Easily Corrected

It is the author's opinion that all existing motor vehicles will be scrapped in the next four or five years because of wear and tear and of inability to use the grades of commercial gasoline that can be produced by cracking methods. To get more yield from crudes from now on means the use of heavier hydrocarbons, requiring something more than merely additional heat in carbureters and manifolds.

The consideration of any theory for increasing refined oil yield can be confined to the new production in the tractor, truck, passenger car and airplane fields. Stationary, marine and gasoline-electric fields form but a small percentage of the total. Engines for such purposes are not limited by space so that perhaps the dry gases for use in fuel mixtures can be made in several ways, even if by methods cumbersome and wasteful of fuel.

Thus the almost stationary production of crude oil, the use of only 18 per cent of the crude oils produced as commercial gasolines, and the use of the wet-mixture method of carburetion with its dilution of lubricating oils, have become most colossal economic problems. The curtailment of the use of passenger cars, or the painfully small saving of gasoline possible if the 5,000,000 gas engine users stop the so-called leaks, offers no permanent solution of these problems.

How can we expect fuel economy if we do not fix carbureter adjustments as such, and also heat conditions? In wet-mixture methods, no attempt is made to fix pressure, temperature, or time limits either in the air or in the fuel as liquid, vapor or gas. These fundamentals not being fixed, how can the ordinary person be asked to save a million gallons of gasoline per day by better carbureter adjustments, when the carbureter or engine designer fixes nothing relating to the fuel? Can we much longer conceal our faults as engineers by the time-worn excuse that the average gas engine owner does not handle things right? How can he, under existing conditions?

The solution of this problem, either during the present war or at its close, when demands for commercial gasoline will greatly increase, requires the adoption of far-reaching methods instead of mere palliatives that will only put off the day of reckoning.

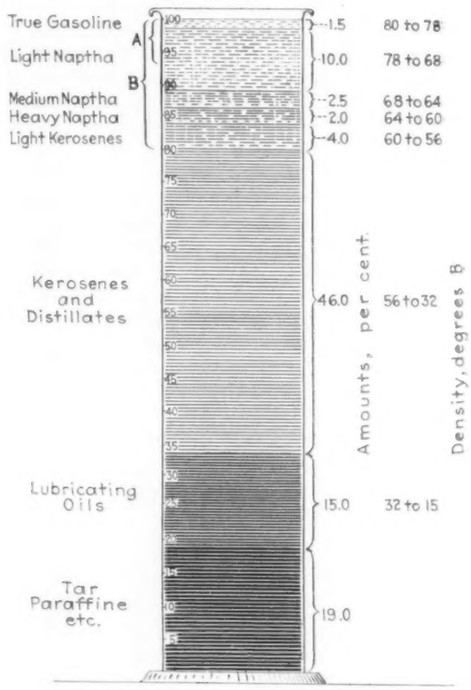
Advantages of Suggested Remedy

The author's suggested remedy—the more general use of superheated homogeneous fixed dry gases made in vaporizing devices independent of engine cylinders—is advanced because he realizes that even personal interests are best served when the entire industry best serves the public. He does feel, as a result of many years of painstaking work and expenditure of huge sums of money in investigating other methods, that this is the only commercially practicable means that can now be devised.

Fixing prices of crude oils below commercially adjusted market prices will curtail oil-well development, and defeat desired results. Fixing prices of gasolines without appreciating that most of the oil refiners' profit comes from gasoline sales, will break down ability to improve refining methods, which are costly at best. Arbitrarily curtailing use of passenger cars or trucks strikes at the basic fabric of the American transportation system. These vehicles handle a larger traffic than steam and electric lines, as they perform local service impossible otherwise. We must depend on more trucks and vehicles with better highways to handle the future increase of traffic that steam lines cannot handle. Restricting rapid expansion of tractors is suicidal as regards the food question, because millions of men and animals lost in the war must be replaced by mechanical power on farms in all the nations involved.

The final solution of the fuel oil, gas engine and carburetion problems is to allow all industries involved to expand along the line of least resistance, which seems to be to allow oil refineries to use more than 18 per cent of crude oils for gasolines, and to include ultimately everything above lubricating oils in specific gravity. To enable the refiner to attain such results, however, the carbureters and engines must be made to handle the heavier hydrocarbons so as to secure flexibility of control equal to that obtained with true gasoline, and also greater fuel economy than with existing wet-mixture methods.

Superheated homogeneous fixed dry gas methods of utilizing oils and air seem clearly to be the highway along which engine design and carbureting methods must travel in order to get power, service and operating economy, to a degree heretofore impossible with wet-mixture methods. Superheated steam has come to stay for steam-engine operation, and superheated gases are likewise in order for gas engines.



SHOWING AVERAGE CUTS IN CRUDE OILS NOW BEING PRODUCED

MAKING SUPERHEATED DRY GAS

To make superheated homogeneous fixed dry gas, all the air must be preheated to the highest possible temperature in order to fix the temperature. The liquid in the carbureter must not be heated because fractional distillation of the lighter hydrocarbon will result. The viscosity of the oil must not be reduced too much, as it overcomes the capillary retardation in the nozzles when the engine warms up.

Air valves are required to overcome surging in manifolds due to the opening and shutting of the engine valves, to cushion intermittent suction pulsations, to prevent loading when the throttle is opened quickly, and to allow a fairly even oil and air ratio at all times. The fuel must be prevented from reaching the heated manifold-walls or cylinders in a liquid state. Heat must not be applied in such a way as to cause cracking of oils, or actual combustion before ignition. Intake valves must be closed on dead center to prevent breaking the vacuum.

Lean mixtures, about one part of oil to from 8 to 15 parts of air, are required in present engines. The ultimate limits are much higher in engines designed on a superheated basis. Only dry gas should be superheated so as to maintain it in such a condition during expansion on the intake stroke. Meter adjustments must be fixed so as to leave nothing to vehicle users for adjustment. With the superheaters smaller engines and simpler engine castings can be used.

Every member of the Society should carefully consider the possibility of using superheated homogeneous fixed dry gas, even though the method may be contrary to the existing wet-mixture basis, in which cylinders are used as vaporizers and flame spread for gasification functions.

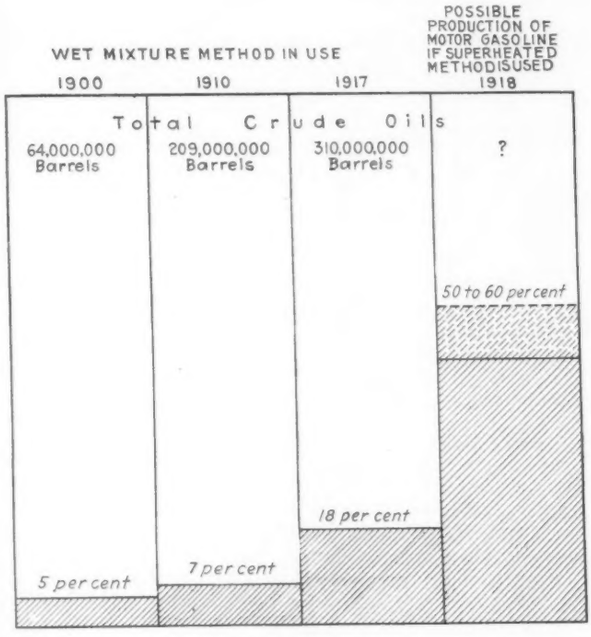


CHART SHOWING CRUDE OIL UTILIZED IN COMMERCIAL GASOLINE AT VARIOUS TIMES

The fuel problem today is similar to Booth Tarkington's story of an inventor's explanation as to why the Wright Brothers made an airplane that really did fly. His idea was that the Wrights, not being conventionally educated in mechanics, had not learned that certain things could not be done, so they simply proceeded to do them.

Data on Actual Performance

With mixtures of about half gasoline and half kerosene, for instance, the following performance figures have been obtained:

Name of Vehicle.	Average Mileage per Gallon Wet Mixtures.	Dry Gas.
Buick Big Six, 1916.....	10	16
Studebaker Six, 1916.....	10	16
Cadillac Eight, 1916.....	10	16
Packard 2-ton Truck, 1914..	5	8
Ford Passenger Car.....	20	30 to 33
Mack 2-ton Truck, 1913.....	5	8
Packard Four, 1910.....	9	15
Overland 79.....	15	24

All these vehicles had greater power and flexibility as well in routine work, even when handled by the people who obtained bad results with wet-mixture constructions.

Cooling water temperatures were automatically maintained between 90 and 130 deg. fahr., without thermostats or radiator shutters, when fan belts did not slip. All were using the same superheater equipment, with a standard adjustment for commercial work.

Easy starting on low-grade fuels is purely a question of engine, manifold and priming method design. In stationary engine work, superheaters use kerosene or distillates. Starting on ordinary gasoline, they equal Diesel-engine fuel economy.

More Efficient Use of Fuel Needed

Prophecy is a dangerous pastime, but if the present world-wide war lasts much longer, economic necessity will ultimately compel some military dictator to prohibit the sale of any motor truck or passenger vehicle, using oil fuels which when running at an average speed of 10 m.p.h. on ordinary roads do not give at least 75 to 80-ton-miles per gallon of fuel. Such a vehicle should do 40 to 45 ton-miles per gallon at an average speed of 20 m.p.h. on similar roads. That military dictator will find that ultimately to win this World's War so far as the Allies are concerned, he cannot demand the fuel oil necessary for military purposes, and tell the rest of the world to "go hang, and do without." There will be no need for the military fuel if all other supplies fail to reach the men at the front.

The weakest link in the complete transportation establishment of the Allies, as a single fighting unit, which it must be to win, is the one that regulates the movement and volume of raw material from the source to consumption on the battlefield. This weakest link, now unsettled, or not provided for, is the so-called gasoline shortage, which is caused mainly by present wet-mixture carburetion methods.

THE DISCUSSION

C. J. ROBINSON:—The author of the paper has stated that there are two methods of increasing the quantity of engine fuel. First, the introduction of the higher boiling point of the petroleum; and, secondly, the employment by the refiner of cracking devices for the production of more low boiling-point factors, or the actual manufacture of gasoline from the heavier product.

Most of the means for manufacturing gasoline from heavy products depend on the heating of the product in the tubes or otherwise to high temperatures. These methods involve a great waste of the product, so that at best they are not economical, although the refiner is compelled to employ such methods in order to keep up and maintain the supply of gasoline.

All the products from petroleum at present are utilized in some way or other. If large quantities of petroleum are turned into gasoline, with the considerable waste that results, the lubricating and other branches of the business will suffer.

There is no waste when the boiling point of the mixture is increased and the carbureters arranged to handle such a mixture. It is not necessary to put in all the kerosene; if only a part of the better portions of the kerosene is added to the gasoline the mixture is much better than that obtained by merely mixing kerosene and gasoline.

It has seemed to me that manufacturers can produce a carburetion method with which a much poorer gasoline could be used than is now put upon the market. They have already made great improvements. I doubt whether the carbureters of a few years ago could handle the product that the refiners must sell at present in order to keep up the supply. It is not unreasonable to suppose that further improvements can be made, and that the supply of available gasoline can thus be increased greatly.

On the pound basis, the lighter hydrocarbons have only a slightly greater heat value than the heavier ones. For instance, gasoline has only 2 per cent greater calorific power than kerosene and only 4 per cent more than gas

oil. Fuels are not bought by the pound, but by the gallon. A gallon of the heavier product outweighs a gallon of the lighter products to such an extent that it more than compensates for the slightly greater hydrogen content of the latter; the heavier products, therefore, containing a greater quantity of heat will drive engines of any kind more efficiently, and will produce more power than the lighter ones, if properly carburetted.

For instance, kerosene has 7.3 per cent, and gas oil more than 12 per cent more heat than gasoline. Diesel engines actually obtain this increase in heating value.

The users of automobiles, even with the present carbureters, waste gasoline unnecessarily. Gasoline engines should be run with the greatest possible quantity of air, and cars should be arranged so that the carbureters can be adjusted from the dash. A carbureter cannot be adjusted so that the car will run slowly in traffic and that will also give the best results at high speeds. Consequently, all cars should be arranged (I think some of them are at the present time) so that as much air as is possible is used. The users of automobiles should see that they are using the maximum amount of air, pushing the quantity up just to the point where the engine will not stall. This will not only increase the mileage from the gasoline but will prevent a great deal of cylinder carbonization and injury to the valves.

A. L. CLAYDEN:—I believe that the automobile engineers of the whole world have been passing the "buck" for the last ten years. They knew that gasoline was only going to last for a short time.

I once heard it said that gasoline had been provided so that the world could learn how to make an internal-combustion engine, that just enough gasoline has been put into the earth to enable that engine to be perfected, and that just as soon as the people began to get lazy about carrying the development further, Heaven was going to cut off the supply and compel them to put in some real work to find a substitute. I think we are faced with a situation very much on that order.

Gasoline of the old sort was liquid gas; there is not any more liquid gas, or what there is of it is of such small quantity as to be negligible.

The further we have to refine our fuel, however successful we may be in the means of doing it, the more the refined fuel will cost than the unrefined. Therefore, the obvious thing to do is to use the unrefined fuel directly in the engine.

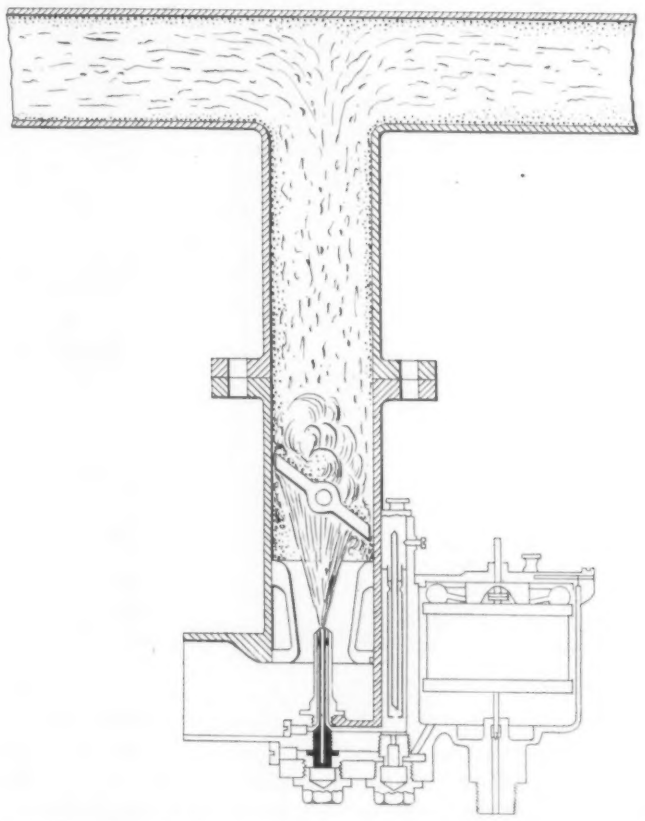
I believe that the worst thing that engineers have done has been to worship volumetric efficiency. Volumetric efficiency has been made a sort of artificial goal by racing and by other forms of competition that limited engine capacity.

Ask any engineers what horsepower they are getting per pound of car or of engine, and few can tell. And these factors seem to me to be of much more importance than horsepower per cubic inch.

I believe that it is immaterial whether the use of superheated gas decreases the volumetric efficiency. Is it not a fact that the drop in volumetric efficiency may be due to a drop in the maximum pressure, and that, in turn, enables a reduction in the weight?

A bicycle weighs about one-third as much as the man it carries. A light motorcycle weighs from the same to twice the weight of the man it carries. An average motorcycle weighs from two and a half to three times the weight of the man who rides it. A really light five-passenger car weighs from four to five times as much as its load; so that in transporting five people five times as much work is done as is necessary in transporting one. I believe that thought wants to be driven home until we have discovered how to get rid of a good half of the dead weight which we now carry about.

I want to ask to what extent alcohol can be used with the superheated method described for handling mineral



ACTION OF PRESENT-DAY COMMERCIAL GASOLINE IN ORDINARY CARBURETER, INNER WALLS BEING WET WITH OIL FILM

oil. I believe that we must consider alcohol as a fuel, if not immediately, in the not far distant future, because mineral oil is a product which, while it may last our lifetime, will not last far beyond that.

The attempts to liquify coal have not been encouraging, and there again is an example of a raw product that requires treatment to render it into a different form.

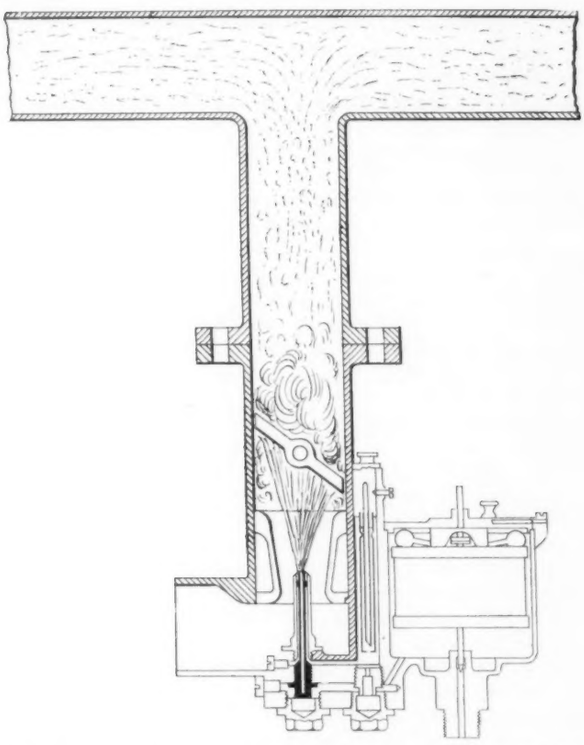
The natural source of alcohol, is that part of the world in which vegetable life is extraordinarily abundant. Today we do not know how to take the tropical forest and turn it into liquid fuel, except at great cost, but we shall know one of these days. That is a problem which no one yet has attempted to solve on a large scale.

A belt around the globe, probably a thousand miles wide, is, so far as we know at present, good for nothing except to grow plants; and it will make them grow almost faster than man can cut them down. There, certainly, is a source of direct energy from the sun, and one that we have at the present time.

W. P. DEPPÉ:—Alcohol is just as difficult to start with and is apparently almost as hard to carburet as is straight kerosene with wet-mixture method machines.

My own idea about alcohol (this is a prophesy and a guess) is that it should not be used alone. It involves radical changes in engines. It is possible, not only in the wilds near the equator, but also under our very noses, to use tractors for deep plowing and produce unheard-of volumes of vegetable matter, such as beets up to 40 tons

per acre, from which animal food could be obtained as a by-product. The pure alcohol could be delivered to the oil refiner to mix with his oil. I find pure alcohol will mix readily with the present-day gasoline in equal parts, I do not believe denatured commercial alcohol will mix or stay mixed when it is used with mineral oils.



VIEW OF TRUE GASOLINE ACTION IN ORDINARY CARBURETER, INNER WALLS OF MANIFOLD BEING MOIST

It is my casual observation that the mixture of half alcohol and half mineral oil produces about the same result in power and flexibility in superheaters as a half-gasoline and half-kerosene mixture.

E. B. COBB:—I take exception to the statement about alcohol. The alcohol that one can buy in the market does not mix with gasoline in the proportion stated, unless the gasoline is of the heavy California type.

YIELD FROM THE CRUDE

The various crude oils taken from the ground do not all yield the same amount of gasoline. A heavy crude oil will give so many barrels and light crude much more. A heavy crude may give more by the ordinary cracking process, but then the question comes in, Will it pay to do it? So much coke, gas, oil and cheap products will be obtained that the price received from all the products will not pay for running the crude. At present, we are using Kansas crude oil, at one of the seaboard refineries. We may take off about 12 per cent of gasoline. After that the material left in the still is run down to coke and the distillate put in the steam still, which is nothing more nor less than a closed boiler with a perforated steam pipe in the bottom and a pipe leading from the top to conduct the vapor into the condenser coil surrounded by water. Application of live steam to the distillate carries the gasoline vapors produced by "cracking" while running down to coke, over where they are condensed. From this process we may get another 12 per cent, making 24 in all. While we are running down to coke, we get so-called gas oil usually supplied to the gas works, to which the Burton process may be applied, giving about 5 per cent more gasoline. Therefore, 29 per cent is about the limit which we can expect from this Kansas crude. It is not practical to continue the cracking process further because the cracking leaves the material in a poorer state. Cracking takes place only when certain hydrocarbons are present; when they are all used up, there cannot be any more cracking unless more strenuous and costly methods are used.

The great trouble with cracking by means of heated tubes is that the first run may give a very encouraging result. A good deal of gasoline is obtained, perhaps, but the tubes, it will be found to fill rapidly with coke, and they must be torn out and new ones put in.

In making a lower grade of gasoline a possibility of the future we do not want to mix in kerosene; we only want the lighter kerosene. The present grade gasoline starts to boil at about 110 deg. fahr., and finishes at a "dry point" around 400 deg. Kerosene will start to boil at about 300 deg. and finishes around 550 deg. We want to put in a little more of that light portion of the kerosene, that is extending what has been done in the past years, giving a 59 or 60 deg. gasoline instead of the former 70 and 71 deg. grade.

The greatest trouble with the present-grade gasoline is in starting. For priming I have always encouraged the use of a gasoline that has a gravity of perhaps 70 or 76 deg. Even if it costs a dollar a gallon, if there is a demand for that material, it will appear on the market. If a thin copper tube is connected from the intake manifold through the dash to a priming cup, so that the driver can introduce a small quantity of this fluid, the engine can then be started in zero weather on the first revolution. After the engine warms up, there is never any trouble which cannot be remedied by the air temperature.

I have made a number of tests with Mr. Deppé, and I can confirm all his statements. He had a car supplied with the equipment that he described. I put in the kerosene and gasoline myself and he took me over country where I was acquainted with the hills and knew just what a car ought to do, and it certainly made good. We made mileage tests and hill tests with a passenger car, and finally we made tests with a motor truck, and all came out satisfactorily.

Navy Requirements

Only the other day I received a specification termed, "United States Navy Schedule 935, Specifications Covering Gasoline." The name is sufficient to show the merits of the specifications. It specifies that the boiling point shall not be higher than 140 deg. fahr. For the gasoline for sale in New York City the boiling point is 105 to 110 deg. fahr. The 140 deg. must be obtained by a method that gave twenty-one points higher than our method. "Boiling below 221 deg. fahr., 20 per cent plus." (Commercial gasoline is running 25 per cent.) "Boiling below 275 deg., 45 per cent plus." (Commercial gasoline is 60 to 61 per cent.) "The end point not higher than 428 deg. fahr." as against the commercial product showing 395 deg. fahr. In every case these specifications are lenient as compared with tests of gasoline found at service stations.

I feel that the problem is up to the engineer. He should be prepared to meet a much less volatile gasoline than now found on the market. I believe the solution lies in controlling the temperature through wide limits of the air entering the carbureter.

J. F. WINCHESTER:—I have attended S. A. E. meetings for the last five years, and I believe that if a man had gotten up at one five years ago and advocated the using of a lower grade fuel than 66 or 69 deg., he would have been hissed out of the hall.

I think that the fuel as it stands today is good enough for all ordinary uses. The average garageman will ask for something better, because such societies as the Society of Automotive Engineers have advocated it.

I have had occasion to use models of trucks that have come out on the market within the last few years. One 2-ton truck, for instance, gave 4 miles per gallon of gasoline. The best carbureter men were unable to make any improvement. But I could take a 3½-ton truck, made by the same manufacturer, and get six miles on a gallon of gasoline. I say that is due to poor engineering.

The maker changed the camshaft and put in different valves on that 2-ton truck. Then he changed the gears at the rear wheel. As a result today, with a little different carbureter, instead of getting 4 miles we are getting 9 miles from that same truck.

I use nothing but lubricating oil, for a light grade of Polarine, and with the Standard gasoline, such as is marketed in New Jersey, I have run trucks eighteen thousand miles without grinding a valve. The loss from burnt-out bearings during the last year and a half, with the four hundred and eighty-five bearings that we have running in the motor trucks, has been less than half of one per cent.

Last winter we believed we could market higher grades of gasoline. We used 50 deg. gasoline in motor trucks all winter, and had no trouble at all. The trucks were started by priming with 76-deg. gasoline.

Some of the drivers would complain about the engine skipping in city traffic. It is difficult to prevent that at low speeds, but the efficiency as a whole was fine compared to what it was with the 62-deg. gasoline.

My end of the business is the operating end and I know that some of the engineering work in magnetos and carbureters is not what it should be. We need an improvement in them rather than in the gasoline and oil.

H. V. R. SCHEEL:—Will Mr. Deppé explain the superheating device mentioned in his paper?

Operation of Superheater

W. P. DEPPÉ:—It works entirely opposite to wet-mixture devices. We use small nozzles in the low speed and probably a shade larger in the high speeds, which is usually contrary to the wet-mixture machines. We use hot air on all inlets. We cannot apply high heat to the oil directly, but must find means of getting it into a vapor form.

From the way wet-mixture carbureters are being developed it seems to me we are trying to build a house by beginning at the third floor; it is like digging the cellar halfway and then jumping up. Those intervening stages must be filled in; we must remember that to get superheated gas before the moment of ignition it must be sent into the cylinders at a temperature slightly below that at which it will ignite in order to allow for heat lost in the cylinder in expansion.

We thought we had reached the limit to which we could carry the superheat, but we have found that by making mixtures thinner the superheat can be increased to an extent that we did not believe possible.

The device makes use of vacuum, and a mechanical spraying effect, in a special throttle. It does not try to heat air in a round tube, because a round column of air, moving in a vacuum with great rapidity, cannot be heated readily. The problem involves something more than merely heating air or having hot spots in a manifold or the cylinders very hot. We believe that the cylinders must be kept cooler than ordinarily, because if the fuel production is increased the lubricating oil boiling points must be decreased in the same degree to gain in volume in refineries, as the best lubricating oils with high boiling points are limited.

AERONAUTIC BOOKS THAT SHOULD BE READ

A writer in *Flying* of London recently called attention to the fact that the bibliography of aeronautics published by the Smithsonian Institution in 1910 contained 13,500 titles, all of which it is not necessary to read. In his opinion, the following should not be missed:

"Langley Memoir on Mechanical Flight," by Langley and Manly.
"Aerial Navigation," by Sir Geo. Cayley.
"Aerial Locomotion," by F. H. Wenham.
"Gliding," by Percy Pilcher.
"The Flight of Birds," by G. A. Borelli.
"L'Empire de l'Air," by L. P. Mouillard.
"Airships, Past and Present," by A. Hildebrandt.
"Aircraft in Warfare," by F. W. Lanchester.
"The Aeroplane," by A. Fage.
"Bird Flight as the Basis of Aviation," by O. Lilienthal.
"Design of Aeroplanes," by A. W. Judge.
"The Mechanics of the Aeroplane," by Captain Duchêne.
"Airscrews," by M. A. S. Riach.
"Pocket Book of Aeronautics," by H. W. L. Moedebeck.
"Nouvelles Recherches sur la Résistance de l'Air et l'Aviation," by G. Eiffel.
"Stability in Aviation," by G. H. Bryan.
"Artificial and Natural Flight," by H. Maxim.
"Aerodynamics and Aerodonetics," by F. W. Lanchester.
"The Properties of Aerofoils," by A. W. Judge.
"Aero Engines," by G. A. Burls.
"High-Speed Internal Combustion Engines," by A. W. Judge.
"The Aero Engine." by Kean.
"The Aeroplane Speaks," by H. Barber.
"Animal Flight," by Hankin.
"Le Vol des Oiseaux," by Marey.

These titles are representative of both historical works and of modern books dealing with the latest phases of the subject. The book on "The Properties of Aerofoils," by Mr. Judge, was reviewed in the July issue of THE JOURNAL.

Design of an Enduring Tractor

By F. H. CRAVEN* (*Non-Member*)

MID-WEST SECTION PAPER

THERE is not at present a type of tractor generally accepted as standard design. Eight years, the life of the industry, has not been long enough for designers to accept and to combine the salient features of all the commercially successful machines, as has been done in the automobile field. We have been told by experts in and out of the industry what the ultimate type of engine will be and what the tractor must do. In the meantime, the user must exercise good judgment and mechanical knowledge just as formerly he used his knowledge of horseflesh. Totally unskilled labor has no place in connection with the operation of any motive power. Be it horses or tractors, the unskilled man must quickly learn to care for them, or they soon become a total loss.

In a paper read some time ago, the student of tractor engineering was offered the choice of a four-cylinder automobile-type engine, which was ably described, and a two-cylinder opposed engine, with its disadvantages dwelt upon, as the ultimate powerplant for tractors.

Prophecy is not of extreme interest to engineers, because, to be commercially successful, designs must be based upon past performance. The evolution of the ultimate type will follow a process of natural selection by future designers from the best works of their predecessors.

The factors that influence design at present are: The prohibitive cost of gasoline for field work, the scarcity and high price of skilled labor, the inability of manufacturers to secure certain materials at all, or in sufficient quantity, necessitating the substitution of others and the modification of design.

The farmer can pay more for a tractor than formerly, owing to the greatly increased prices received for his produce. The increased price received by the manufacturer enables him to give more attention to refinements, leading to longer life and greater economy of operation.

The industry, as a whole, has suffered in the last three years by offering to the farmer many ill-digested implements termed tractors by their sponsors. Happily, a reversion to sounder and more conservative designs is now to be noticed.

The type of tractor about to be described is eight years old, and today, although modified and refined in detail, is essentially the same as when first put on the market, when anything but a steam engine was unknown upon the farm. A mechanical creation must be judged by the length of its useful life, together with the amount of work performed. It is safe to say, from past experience, that tractors of this type have a useful life of ten seasons with a proper amount of upkeep attention.

Operating Requirements

The stationary internal-combustion engine is expected to deliver its rated horsepower continuously all day long, perhaps all night, also. A tractor engine under proper working conditions is called upon for 75 per cent of its rated horsepower continuously during operation, and must deliver the remaining 25 per cent when needed to overcome obstructions in the path of the plows, to cut through roots, or at the moment before the breaker pin relieves the plow point caught under a rock. Slow speed and large bearings are necessary to long life in the tractor engine.

The automobile engine leads a lazy life, and, in spite of occasional spurts, loafs through its average day's work, being called upon for only 20 per cent of its rated output, and that not by any means continuously.

It would, then, seem reasonable that the tractor engine should resemble more the sturdy stationary type rather than the speedy automobile type.

Early automobiles with slow-speed engines of one or two cylinders gave place to the present four, six and eight, or even more cylinders, in order to obtain greater flexibility, less weight per horsepower and less noisy operation.

These reasons for change were imperative in the development of the automobile, but should not influence the tractor designer. An engine of constant, governed slow speed, few parts, and freedom from frequent and delicate adjustments, should be the aim.

Proper Size of a Tractor

Let us denote the size of a tractor by the brake horsepower of its engine, discarding the usual dual horsepower description. In selling a tractor it should be described as of such a brake horsepower at its belt pulley or band wheel, and as being able to pull so many 14-in. plows under ordinary conditions. The experience of the last three years has proved that the useful size of tractor must handle three or more plows, and another year will perhaps demonstrate that four plows is the more satisfactory minimum.

The British Food Commission, handling the government end of the tractor business in the United Kingdom, inclines to the use of a four-plow outfit, these to be stationed in districts according to the amount of arable land, and used for custom plowing. It is certain that a two-plow tractor, traveling at horse speed, will not relieve any shortage of labor. We may expect the individual user to arrive at the same conclusion as the centralized operating agency, only more slowly.

A suggested range of sizes would be 20 hp., 3 plows; 30 hp., 4 plows; 40 hp., 6 plows; and 60 hp., 8 plows. The last size is limited in use for plowing, its great horsepower being used for operating the largest separators.

It is essential that these engines be oil engines, not merely kerosene burners, or gasoline engines with kerosene attachments. The present-day tractor engine must burn kerosene, distillate or heavier oils at all times, at all loads, and under all conditions. Gasoline should be used only in small quantities for starting cold.

Use of Lower-Grade Fuels

Having no choice as to the fuel, let us consider how it can be put to work with the least loss. We can drop the use of the word carbureter as being a term handed down from the days when the fuel of internal-combustion engines was a liquid hydrocarbon, volatile at the ordinary temperature of the air; all that was necessary was to

*Engineer, Advance-Rumely Company.

expose it by wick or other means to the air drawn over or through it. The surface or wick has been superseded by the jet carbureter, for good reasons; nothing better than the latter having been devised, we must use its principle in a fuel mixer to atomize fuel, since it can no longer be vaporized. To make an oil engine successful we must note the following elementary principles:

The intake manifold must be short (none at all would be better). The working temperature of the combustion chamber must be maintained within close limits. The proportion of air to fuel must be closely regulated. These two last conditions should be attained by the action of the fuel mixer.

The fuel mixer can vary widely in mechanical detail, but the underlying principle should remain that of inducing the fuel to rise through a tube with a restricted orifice by means of air drawn past it under the action of the piston; the air current breaking up the fuel into a mist as it issues from the jet.

The body of the fuel mixer can consist of a vertical air intake mounted on the cylinder head. Around this should be cast a circular chamber divided into three parts; each of these communicating with the central air intake by means of a spraying nozzle, manually adjustable by a needle valve.

One of these chambers holds the starting gasoline, and is replenished as needed. In the other two, fuel and water is maintained at constant level by overflow pipes returning to the supply tanks below. Since means must be provided for elevating the fuel and water from the supply tanks, the overflow pipe is a simple substitute for the float valve.

Where the spray nozzles project into the air intake the latter is restricted in the form of a venturi tube to impart a high velocity to the incoming air, which at this point draws the fuel and water through their respective spray nozzles, atomizing the mixture and carrying it into the cylinders.

To complete the fuel mixer we need only to connect a throttle valve either of the butterfly or barrel type to a positively driven centrifugal governor. This should give a speed control within 2 per cent from full load to no load.

Venturi-Tube Adjustment

A refinement that will help to maintain a more constant opening is easily incorporated into this fuel mixer by constructing one-half of the venturi-tube wall so that it can be moved and of such form that when linked to the governor-controlled throttle the effect of a contraction or enlargement of the venturi tube is obtained on the opening or closing of the throttle.

With the throttle almost closed, as when idling, the venturi tube will be contracted, the velocity of the air will be increased to compensate for the reduced quantity passing the spray nozzles, and the composition of the mixture will be kept more nearly constant.

Drawing the intake air through a hot stove on the exhaust pipe is not absolutely necessary but prevents freezing of moisture at the gasoline jet and supplies the heat required for the partial vaporization of the water used with the fuel, thus avoiding any chilling of the mixture passage.

It is not practicable to apply sufficient heat to the large volume of air to cause vaporization of the heavy fuel, nor is such a course desirable with this system of oil burning.

In the tractor field, in which all parts must be simple and rugged, automatic mechanical devices, such as multiple jets of delicate construction, floats or springs, should be avoided.

Value of Water in Engine

The use of water with the fuel of an oil engine has been described as a makeshift device that can be avoided by the proper design of the combustion chamber, but we are not told just how the combustion chamber can be formed so as to remove and to a great extent prevent the formation of carbon deposits both in it and on the piston head. Carbon deposits are a great source of trouble even in gasoline engines when water injection is not used, yet in these oil engines the removal of carbon is never a cause for dismantling the cylinders, and is found only on taking down the parts for general overhauling.

The permissible range of combustion-chamber temperature for successful oil burning is small compared with that which can be allowed in a gasoline engine. Here lies the real reason for the use of water with the fuel. While maintaining a constant speed, with the capacity of the jacket-cooling medium fixed, the engine is called upon to burn amounts of fuel varying greatly as the horsepower output changes with the load applied. In tractor practice the only practical way to control the internal temperature under these conditions is by the use of water injection. With each change in fuel intake, proportional quantities of water are introduced by the same suction that controls the fuel intake.

Not only is the internal temperature controlled in a simple manner but the initial pressure of the explosion is reduced and the mean effective pressure increased by absorption of heat from cylinder walls and piston heads.

Cylinder Construction

In this persistent type of tractor a pair of horizontal cylinders is used, cast together in the smaller sizes, separately for 40 and 60-hp. engines. The stroke is one and one-quarter times the bore; compression pressure, 50 lb. per sq. in.; mean effective pressure, 85 lb. per sq. in.

The advantages of horizontal cylinders side by side for tractor engines are the low center of gravity, the fact that all manual adjustments necessary while running are convenient to the operator's hand, absence of induction pipes, and the compact appearance of the tractor so equipped.

The proper position of the valves is highly important in an oil engine. The inlet valves, when placed in the upper part of the cylinder head, allow a direct passage from the fuel mixer to the cylinders. The exhaust valves should be low down in the cylinder-head casting and arranged so that on the exhaust stroke the cylinders can draw through them, and that any surplus lubricating oil or unconsumed fuel will be at once expelled.

The cylinders are oil cooled, so that a steady jacket temperature of from 180 to 200 deg. can be maintained. The oil used does not freeze in the coldest weather nor does it evaporate and deposit scale. No fan is used, the exhaust pipe being directed through the plate-form radiator, creating an air current sufficient for all cooling purposes.

A low-tension magneto and make-and-break ignition is used. This has been found to give the most satisfactory results in the field, the least trouble and greatest freedom from sooting when using low-grade lubricating oil. If the usual jump spark was used the igniting equipment would be simplified, but unless the lubricating oil were of high grade, sooting and general dissatis-

faction would result. Therefore, in the interests of economical operation some increase in initial cost is justified.

Methods of Lubrication

Early attempts soon proved the simple splash method of lubrication defective, owing to dilution of the lubricant by unexpended fuel. The change was made to a positively driven force-feed pump having leads to the cylinders and main bearings. The connecting-rod big-ends are supplied by catcher rings on the crankshaft webs, which take the oil pumped through the main bearings. By this means fresh oil is continuously supplied to the critical points, leaving these to renew the crankcase supply, where a level is automatically maintained. Any excess causes an extra splash, and consequently passes the piston and is blown out.

The flywheels on these engines are heavy, ranging from 42 in. diameter with a weight of 400 lb. on the smallest to 1300 lb. with a diameter of 48 in. on the largest; engine speeds vary from 530 to 375 r.p.m.

With these heavy flywheels careful attention must be paid to the design of the transmission shafts and gears. It is not sufficient to make them equal only to the task of conveying all the power of the engine to the drive wheels. They also must sustain the impact delivered by the energy stored in the flywheel rim should the tractor meet a sudden obstruction.

The band wheel or belt pulley is free to revolve upon the crankshaft and on an extension of its hub is located the traction pinion. An expanding shoe clutch connects the band wheel with the engine, so that the tractor can be backed into the belt when threshing, and the separator started or stopped without stopping the engine.

The transmission train, with ratios varying from 1 to 37 and 1 to 42, runs in an oil-tight case, the spline shafts running on roller bearings. A reverse and two forward speeds of 2¼ and 3 m.p.h. are provided. The former is the normal plowing speed, the higher speed being used for the lighter field work and for traveling from place to place. A spring-cushioned differential is used, and all gears are enclosed, except the final drive, from master pinion to bull gear.

Design of Drive-Wheels

The drive-wheels range from 54 to 80 in. diameter, and are built up with beaded-edge tires and headed flat spokes. The steel angle cleat of standard structural shape has proved its all-round superiority as regards gripping, ability to stand abrasion and ease of detachability. Special cleats of twice the usual height and of extra length are used for soft or newly plowed ground. With the increase in number of improved hard-surface roads, detachable land cleats are imperatively needed. Permanently fixed cleats may be of such length and so disposed upon the drive-wheel as to present an unbroken perimeter to the road, thus producing no jar, but they would soon ruin a concrete or brick roadway. For traveling from place to place the land cleats must be removed and something else substituted. A satisfactory road wheel is produced by punching double the number of holes required for the land cleats and attaching double the number of steel flats by means of countersunk-head plow-bolts. For short trips on hard roads, particularly if no great load is to be hauled, the plain tire with its numerous punched holes will give satisfactory traction.

The success or failure of any tractor as a farm implement depends very largely on the disposition of its weight. Twelve different tractors of this type made by four different makers show 300 lb. per b.hp. as the average weight. From 63 to 75 per cent of this is carried by the drive-wheel tires. Those tractors with short wheel-bases must carry the smaller percentage of the weight in the rear. The shortening of a tractor should not be carried to extremes. Mere weight alone is of little assistance in obtaining traction, yet it is advisable to have as much of the total weight as possible available for adhesion when running with plain tires or flat cleats on hard surfaces.

The diameter of the drive-wheels should be as large as possible; the clearance needed between the drive-wheels and the band wheel with cleats in place limits the former's diameter.

The width of tire must be proportioned to the diameter of the drive-wheels and to the weight carried by them so that the supporting area presented to the ground is sufficient to prevent excessive sinking. Any piece of land will bear a certain weight per square inch; a tractor wheel will sink until the projected area of tire presented is large enough to reduce the load to what the particular piece of ground can carry. This being so, we must assume for purposes of comparison an arbitrary figure of say one inch as the depth to which the drive-wheel sinks. The average tire surface in contact with ground is 18 sq. in. per b.hp., according to figures taken from 18 tractors.

Taking this figure and the weight per brake horsepower of 300 lb., of which 70 per cent is on the drive-wheels, we get a bearing pressure on the ground of 11½ lb. per sq. in. for the tractor described.

Should the land on which the tractor was working not be capable of supporting 11½ lb. per sq. in., the wheels would sink until an equilibrium was established. However, on average land they would not sink an inch.

Author's Conclusion.

This completes a brief description of a type of tractor which is in use in large numbers. It has long passed the experimental stage, but is still being improved without departing from the fundamental principles originally adopted.

The experience gained from its consistent performance over a period of eight years leads one to believe that the ultimate type of tractor that will be generally accepted as standard will not depart widely from the design set forth.

Spring Design for Easy Riding

By WALTER C. KEYS*

PENNSYLVANIA SECTION PAPER *Illustrated with* CHARTS AND PHOTOGRAPH

WHEN I first encountered the problems in connection with automobile suspensions, I was disappointed to find that there were no formulas and data which were easily workable by engineers. It is for this reason that I consider these problems to be of great interest.

Much can be said as to type of suspension. The tendency in American design is now strongly toward half elliptic construction for both front and rear springs. The type of suspension used on many cars was decided upon because the president or general manager believed—perhaps through riding in some friend's car, or through hearing some one express his opinion—that a certain type was best. As a result, the chief engineer was called into the front office and told to lay out cantilever springs for next year's car. As a matter of fact, it might have been much better, from an engineering standpoint, to have kept the old type of suspension, but to have improved it.

The best-known and most generally used spring suspensions are half elliptic, three-quarter elliptic, full elliptic, three-quarter platform, full cantilever, one-quarter cantilever, and single cross spring. These types are so familiar that a description of them is unnecessary. Each type has its own good points, and some types are especially applicable to certain cars. But each type must be correctly worked out for any particular car in order to give satisfaction.

Some years ago an advertising campaign was conducted by a certain company to educate the layman to believe that the underslung frame gave the best type of chassis that had yet been produced. Many reasons were offered. A few other companies followed with underslung construction, and many people believed that the whole industry would follow this precedent. We now know that the underslung construction is, for practical reasons, not superior to the overhung frame. It is not now used by any large manufacturer of gasoline cars in the United States.

Similarly, we saw the bevel-gear drive come, heralded by such cars as the old "Silent Northern." For practical reasons we did not abandon the bevel drive and return to the chain, because we learned that a bevel-gear axle, properly designed and built, gave far better satisfaction than the old noisy chain, which could not be protected from mud and grit, and which often had to be replaced.

Two or three years ago we heard a good deal of talk about cantilever rear springs. Some engineers argued that the greater length of the full floating cantilever resulted in better riding qualities because a slower period of vibration was possible. Much publicity was given to this type of spring by those who adopted it, but I believe that the public has learned convincingly that there is no outstanding superiority of riding qualities of cars equipped with cantilever springs. I venture to say that few men would be willing to wager 50 to 1 that they could pick out a cantilever suspension judging by riding qualities only.

None of us will ever forget the rides we have had over a corduroy road in a jolt wagon. Traveling at slow speed, with no springs of any sort, we found that every unevenness of the road is followed by the wheels and the wagon body. This is one extreme.

Elements of Riding Comfort

The other is the modern automobile, equipped with large tires, properly designed springs, and properly designed cushions. Each of these three elements plays an important part in giving the passengers a comfortable and enjoyable ride.

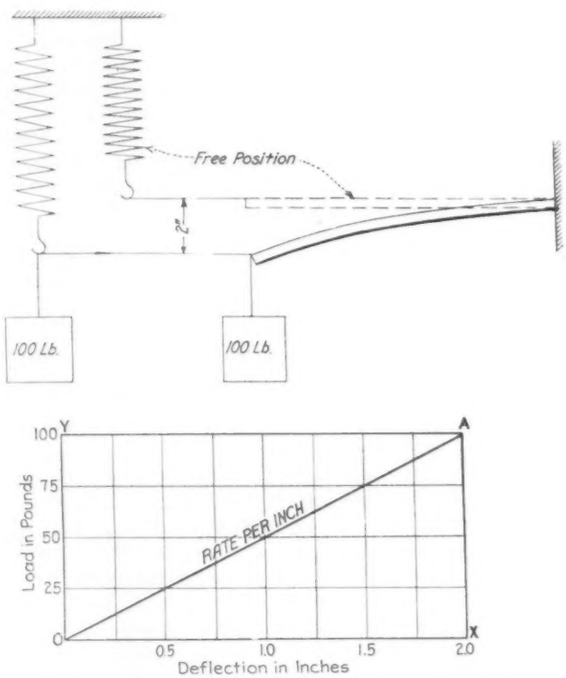


FIG. 1—LOAD CONDITIONS FOR FLAT LEAF SPRING

Tires are depressed by the smaller obstacles an inch or two in height. The springs take care of the larger bumps and depressions in the road—within limits, of course. Cushions, if properly designed, also aid greatly in reducing the jar that passengers receive from rough roads; furthermore, they absorb many small vibrations of the car frame that would otherwise be extremely annoying. (Riding with flat tires or broken springs is most unpleasant.) The next time one rides in the rear seat of a touring car let him place his hand on the molding on the top of the body; he can then observe how much vibration there is that cannot be felt when sitting on the cushion.

The principal function of the chassis spring is to store up and pay out energy. For this purpose the most generally used type is the so-called leaf spring. In this a number of flat plates are bent from the shape they assume when free, to some other form, as load is applied.

*Acting Director of Engineering, Standard Parts Company.

Take each plate separately and load it as a cantilever beam, or take the spring as a whole and apply load to it; we then find that the deflection increases practically directly as the load is applied. In other words, the load-deflection curve is a straight line, and the energy stored up by deflecting the spring a number of inches, *OX*, under a load of *OY*, is represented by the area of the triangle *OXA*. This is fundamental, and applies whether the spring is a cantilever beam or a coil spring in tension, compression or torsion.

To word it more broadly, we can say that if it takes 100 lb. to bend or twist a piece of steel a certain amount, it will take 200 lb. to bend or twist it twice that amount, working within the elastic limit of the material.

Now, the law that applies to one flat leaf spring also applies when two are coupled together, as in the case of a three-quarter elliptic or full elliptic spring. Therefore, we should not expect to find any great difference in the riding qualities of an automobile as we change from one type of suspension to another, other things being practically the same. That this is true is attested by the variety of suspensions used in the United States for the past ten years. If any one type had consistently shown its superiority, car builders would have been forced to adopt it, just as they were forced to adopt bevel-gear rear axles.

If I can assume that I have carried this point, I shall pass on to outline what I consider a good suspension.

The five hypothetical cars (see Table I) are fairly typical of the cars now on the American market. The dimensions of the springs are such as we have found to give good results. The loads and rates per inch are, of course, approximate only. I choose the half-elliptic spring front and rear, because this type of suspension is simple from both the spring maker's and car builder's standpoint, especially if the Hotchkiss drive is used.

In developing any suspension, we must at every stage keep our work practical. In order to accomplish this we must know the various processes of manufacture of the spring, and we must know the use to which the spring will be put. The spring lengths, widths and thickness of plates must be worked out practically, giving due consideration to such factors as weight of car, total deflections and flexibility. I know of no way of arriving at consistently good results in laying out suspensions other than to use good judgment based on records of many good suspensions in past or present use. Compilations of such records are generally carefully guarded by spring engineers, to whom they are especially valuable.

A large number of the automobiles in America are driven most of the time on fairly good roads or pavements. At times, however, the roads and weather are bad, and the driver is in a hurry. It is then that springs are called upon to give their maximum service. No man can have the proper respect for the springs on his car until he has ridden at high speed over rough roads full of bad ruts. The side strains on the springs are enormous, and while the passenger braces himself to keep from being thrown from one side of the car to the other he wonders how those springs under him can be strong enough to hold the axles and frame together.

Functions of Rear Springs

One of the important functions of the rear springs is that of taking the driving and braking strains. In the case of Hotchkiss drive they must also withstand the axle torque due to driving and braking. Familiarity with these requirements enables the engineer to furnish springs which are practical from the standpoint both of manufacture and performance.

Let us not forget that the sales manager wants things practical from his standpoint, too. He wants the car low, and that means small clearance between axle and frame; and that means less flexibility of the springs.

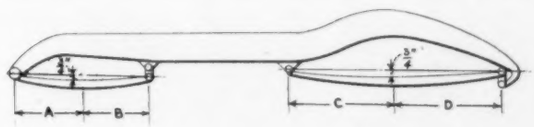


TABLE I—SPRING DIMENSIONS FOR HYPOTHETICAL CARS

CAR		SPRINGS								
		FRONT				REAR				
Weight, Lb.	Wheel-base, In.	*A*	*B*	Width	Bush-ing*	*C*	*D*	Width	Bush-ings*	
2000	105	17	19	1¾	¾	23¼	26¾	1¾	¾	¾
2750	112	18	20	2	⅞	25¼	28¾	2	⅞	⅞
3500	120	19	21	2¼	⅞	26	30	2¼	⅞	⅞
4250	130	20	22	2½	¾	27	31	2½	⅞	¾
5000	136	20	22	2½	¾	28	32	2½	⅞	¾

*Inside diameter.

The curves in Fig. 2 are taken from two springs of the same length, width and flexibility, but having different number of plates. These curves were made by applying loads varied from zero to a maximum of 1700 lb., and then releasing the load gradually to zero again. For each load applied the deflection is recorded. When load is first released the spring does not recoil immediately; there is a loop between the lines representing increasing and decreasing loads. This loop represents the damping effect of the inter-leaf friction.

If it were not for the damping caused by the plates of the springs and the friction of shackles and eye-bolts, the automobile would continue to bounce up and down for a long time after striking a single bump. This damping effect is essential in good suspensions, and must of

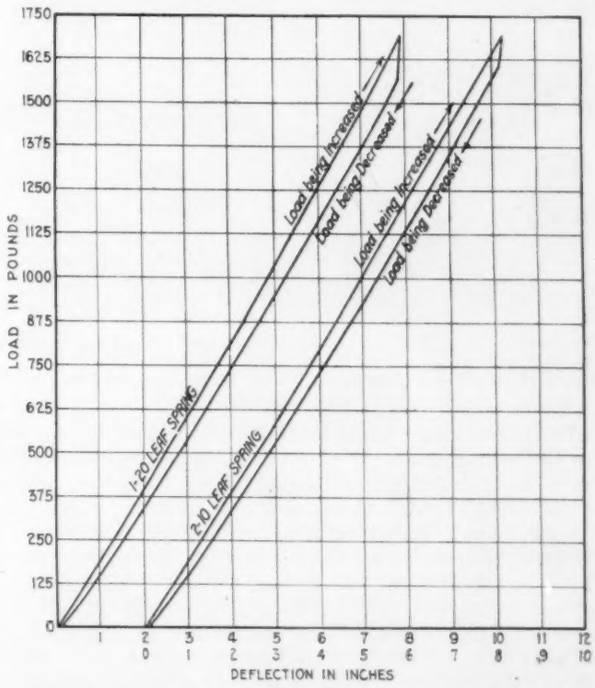


FIG. 2—CURVES FOR SPRINGS OF SAME LENGTH, WIDTH AND FLEXIBILITY

necessity be present to some extent in any suspension that can be worked out for practical use.

The springs on racing cars are always taped, or provided with some dead metal between leaves to further dampen their action. Many devices are now on the market, and in general use, which act solely as dampers to spring action.

Some time ago we brought out "thin leaf" springs, composed of many thin leaves; these have about the same flexibility as the regular springs, but the damping effect is greater. Fig. 2 shows that the loop or damping effect is greater for the twenty-leaf than for the ten-leaf spring.

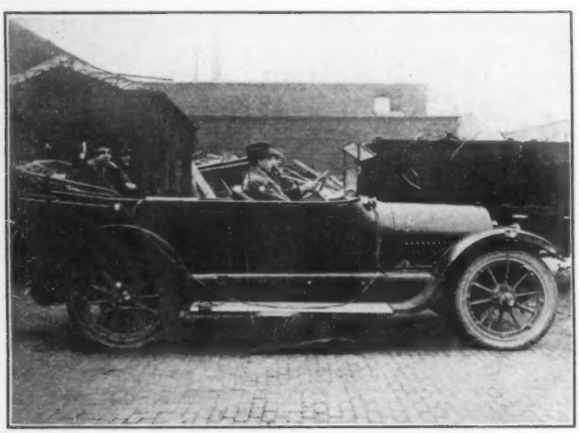


FIG. 3—CAR FITTED WITH APPARATUS FOR RECORDING SPRING PERFORMANCE

Not a great deal can be done with leaf springs other than to design them with proper length and width and to use as large a number of plates as may be considered practical from the standpoint of weight, cost, and total thickness of spring.

In most cars, the springs soon become rusty, and for the most part are not kept in the well-lubricated condition in which they are sent out by the manufacturer. Rusty springs do not work as freely as well-lubricated springs; that is to say, the flexibility is slightly less, and the damping effect is considerably greater.

A recent experiment which I performed with a set of old springs led to the conclusion that by thoroughly lubricating them the riding qualities were improved for driving on pavements on which there were only slight irregularities. However, in driving over rough roads the riding qualities were less satisfactory, because of the tendency of the car to continue bouncing after striking the big bumps.

Riding Qualities

A few years ago I was assigned to the task of improving the riding qualities of a car equipped with a special closed body. After considering every item that might be modified, I had these changes made: First, the pressure was reduced in tires. This did not cure the trouble. Second, softer chassis springs were substituted. Third, snubbers were added on the rear. These changes did not noticeably improve the riding qualities. My last move was to remove all the upholstery in the cushion and seat back. Here the cause of the trouble was apparent, for the cushion springs were of makeshift construction, and evidenced a deplorable ignorance of good construction. Properly designed cushion springs were substituted, the cushions were provided with adequate air vents, and the harsh riding qualities vanished.

The following items affect the riding qualities of an automobile:

1. Speed of car.
2. Flexibility of springs in relation to load carried.
3. Period of vibration.
4. Axle clearance.
5. Wheelbase.
6. Size of wheel.
7. Size of tire.
8. Inflation pressure of tires.
9. Possibility of synchronism of period of front and rear springs.
10. Depth of cushion springs.
11. Period of vibration of passenger on cushion.
12. Position of passenger in relation to wheelbase.
13. Location of center of gravity of car.
14. Relation of unsprung to sprung weight.
15. Flexibility of frame side members.
16. Shock absorbers.
17. Supplementary springs.
18. Spring inserts.
19. Effect of rebound straps.
20. Effect of torque at rear axle and at front of frame.
21. Eccentricity of spring.
22. Tightness of shackles and eye-bolts.
23. Gyroscopic action of rotating parts.
24. Condition of road.
25. Skill of driver in avoiding bumps and holes.
26. Ability of passenger to ride easily.
27. Clothing worn by passenger.

Some time ago a well-known automobile engineer had some engineers out for a trip. As he drove along over a fairly rough road he called attention to the nice action of the springs, which were equipped with an auxiliary device. They reached their destination at a country club, but before going in for luncheon the host invited them to look at the new spring attachment. They went around to look under the rear end of the car, and to the amusement of the guests it was found that the attachment was not on the car at all. That is why I sometimes tell a man that I cannot take his word on riding qualities.

When I first took up engineering work in connection with automobile suspensions I was impressed with the great diversity of opinions regarding riding qualities. A graph or record was needed to prove, in addition to a man's impressions, whether a shock absorber or auxiliary device tended to improve the riding qualities. Magazine advertisements and salesmen's talk might create a market, but they would not convince an engineer.

Fig. 3 illustrates a means of obtaining actual records. Electric lights are mounted on wheels, fenders and passengers of an automobile, which is then driven at night in front of a camera. Fig. 4 shows records made with three passengers in: *A*, Chevrolet, Model F, at 30 m.p.h., and *B*, at 10 m.p.h.; *C*, Buick D 35, at 30 m.p.h., and *D*, Oakland six, at 20 m.p.h.

THE DISCUSSION

JOHN WILKINSON:—I am not an intense advocate of elliptic springs over all others, but I believe that they have some advantages as well as some disadvantages. The question of springs on a car is a difficult one. In the first place, the loads on the car vary a great deal. At one time one and at another seven passengers may be riding in the same car, and we have to use the same springs; or, the roads may be good, bad or very bad.

In our construction the axle is merely hung on the springs; there is no other connection between the frame and the axle. In the rear we do not use a torque-rod. Of course, that is not directly concerned with the spring action of the car. Incidentally, the bottom half of the spring is hung under the axle. The function of a spring is to relieve shock. The sharp, violent shocks are just as disagreeable to some passengers as the large, quick, long movements. The question of whether a car is well sprung or not is really a matter of judgment. Some day, by the aid of such records as Mr. Keys has shown and the experience of all the people trying the cars, we may develop exactly what is best and right, and I think his ideas, if carried out, may help greatly to get the best-running car.

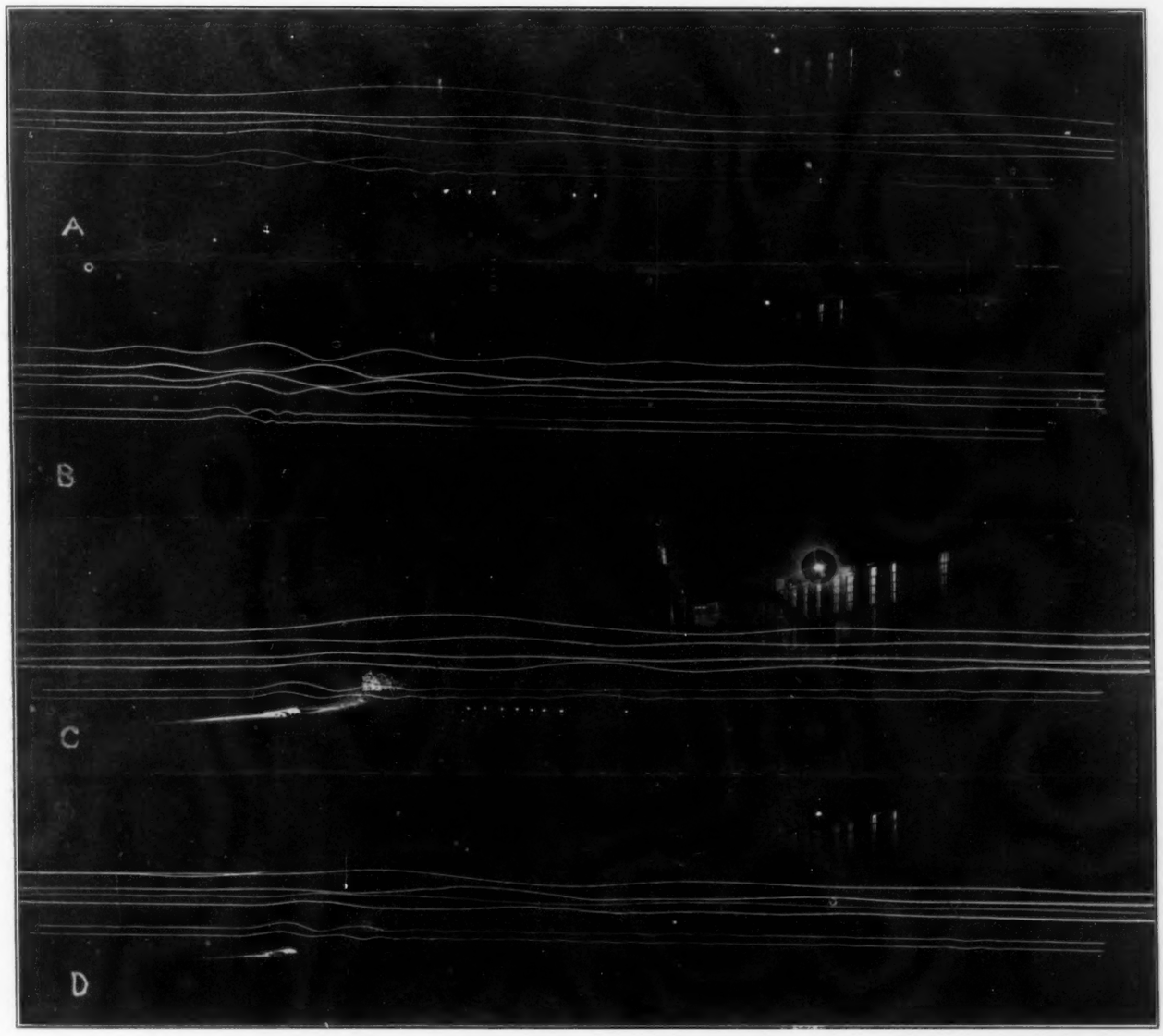


FIG. 4—RECORDS MADE ON PHOTOGRAPHIC PLATE WITH LIGHTING APPARATUS CARRIED (SEE FIG. 3) ON CAR

ACTING CHAIRMAN H. R. COBLEIGH:—Will Mr. Wilkinson tell us how his construction takes care of side sway?

JOHN WILKINSON:—In elliptic springs the distance from the top of the top leaf to the bottom of the bottom leaf on the bottom half of the spring is considerable. In some cases this distance is 13 in. with the springs, unloaded, so that when going around a curve the centrifugal force throws the car over. That is disagreeable, but side-sway on a bad road is just as absolutely necessary for easy riding as is up-and-down movement. A car with flat half-elliptic springs is absolutely the limit on bad roads because it has absolutely no resistance or movement sideways. When anything is hit at the side the car stops and the person in the car goes on. If sitting at the side, the person bangs against the side, and it is also very hard on the car.

Action of Front Springs

I have a good deal of criticism against the springs on the front end of the average car, and I often wonder whether they ought to be called springs at all, because they are so stiff. I once took a car that we had been using in every-day service a long time, and I put a pair of half-elliptic springs on the front end of the car and took it out on a rough run. The axle went down considerably on the first run. I straightened it and put on elliptic springs. The axle then stood up for three runs at the same speed. I tried it again with the half-elliptic

and down went the axle again. Fig. 5 represents the frame, the axle, and the wheel. When the front axle strikes an obstruction which, of course, may be of any heighth, the arrow will represent the line of pressure and the horizontal and vertical component. If the spring is of such a design that it cannot yield in the direction opposite to the pressure, the shock will be transmitted to a much greater extent to the car, and the passengers get the effect of it. A full elliptic spring will "wink" and let the axle move back and take up a large part of the shock.

A MEMBER:—What will that do at the same time to the steering?

JOHN WILKINSON:—By making the angle of the drag link right the shock will have no effect on the steering. That has been proved by driving a car arranged this way. With a flat horizontal spring the center of the axle must actually come forward a little when an obstruction is struck because the spring shortens between the eyes. Of course, a half-elliptic spring can be easily made to give somewhat the effect of the full elliptic, only it cannot wink. If a half-elliptic spring is made properly one end is a good deal higher than at the other.

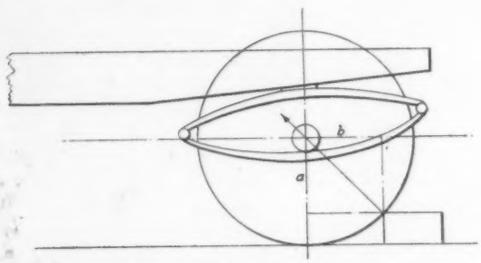


FIG. 5—EXPERIMENTAL AXLE USE IN TESTS

We make many of our springs 3 and 4 in. higher in front than at the rear, in order to get the direction of the shock normal to the spring and to take up some of the horizontal jar. We have tried the following over and over again on the rear of a car. The rear spring is hung the same as regards the spring action. A link and a strut rod are arranged in connection with the spring, as shown in Fig. 6. With such construction, the car is relatively uncomfortable, and we feel all the little jars.

Effect on Universal-Joints

When the load is applied by the engine the elliptic springs wink perceptibly, especially if the clutch is thrown in suddenly. That is easy for the car but it is hard on the joints. The joints must have a long sliding motion, and considerably more angular movement than on most cars. It is probably harder on the spring to require it to take that torque than to relieve it by a strut rod when the construction would be the same as the Hotchkiss drive.

W. C. KEYS:—The old Church-Field electric car was equipped with a three-quarter elliptic spring shackled at the front end, the drive being through the rear half of the half-elliptic and then forward through the quarter-elliptic; that resulted in a 2-in. telescopic action in the universal-joint.

JOHN WILKINSON:—Our old cars ride much better than a new one, because of the friction between the leaves of the springs.

The rear set of springs are the important springs on the car, because the people in the front are always more comfortable than those in the rear, and therefore we should make the people in the rear as comfortable as possible. It is our experience that on the average the less the deflection per inch of spring, the more easily the car will ride. Suppose the car has a 4-in. spring-opening when loaded and a 160-lb. spring; if that could be changed to a 130-lb. spring with an opening high enough so that the axle would not hit too often, the riding qualities would be much improved.

We cannot use stiffness to the same effect on the front as on the rear spring, because the car may pitch. So we have the front spring heavy enough to stop that pitching action. Unfortunately, we make it heavier than we would like to because we know it is stopped on old cars; but we stop it on new cars.

Enameling Spring Leaves

To get the effect of old springs we have separated new leaves, enameled them, and put them together again. The performance of the enameled spring seems, as far as we have gone, to produce this effect. Enamel, of course, results in more friction than the oil generally put in new springs. The spring wears off the enamel only in little spots, not wearing it all off. The high spots are the only ones that wear off, and they are the only places where it can rust. I hope the enamel method may solve the problem and make a new car ride as good as an old one, and keep it always in the same condition.

On our standard car today we are using front and rear springs with a deflection of about 160 lb. to the inch. The front springs are heavier, to take care of the tendency to pitch on new closed cars.

W. C. KEYS:—What is the riding clearance?

JOHN WILKINSON:—It is about 5 in., roughly, with five people in the car and without baggage.

W. C. KEYS:—That is exclusive of a rubber bumper, or including it?

JOHN WILKINSON:—We do not have any bumpers at all; that is the total clearance. We try to get the clearance and the weight of the spring such that the car will not strike the axle except under extraordinary conditions. If a car was touring around the state of Pennsylvania, where the roads are poor, it might strike two or three times a day. There is no harm in striking, but it is disagreeable. On a closed car the weight on the front spring is about 210 lb., and that seems to prevent the pitching action.

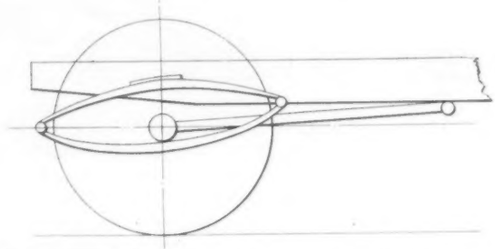


FIG. 6—DIAGRAM SHOWING CONNECTION OF LINK AND STRUT ROD

W. C. KEYS:—Does the 5-in. clearance apply to both front and rear springs?

JOHN WILKINSON:—Yes, but we do not require as much in front. The construction is such that it comes out that way, in order to keep the car at the right level. Of course, we would like more.

A half-elliptic rear spring might be developed that would be a superior spring to anything else, because by

bending the frame and taking all the movement possible, the rear spring could be lighter. Of course, the car is a little higher, but it is foolish to try to get the car lower at the expense of easy riding.

W. C. KEYS:—How much heavier is the closed car than the open car?

JOHN WILKINSON:—From 350 to 300 lb., depending on the type; the sedan will weigh about 300 lb. more. I have never worked out in my own mind just why the closed car pitches more than the open one, but it must have something to do with the center of gravity.

JOHN W. WATSON:—If a car with the softer spring rides more easily, why does a car ride more easily when the spring becomes rusty?

JOHN WILKINSON:—The damping effect of the rust helps the riding more than the extra stiffness hinders it.

JOHN W. WATSON:—Then the rust helps to check the recoil, so that if the spring had rust in it during the recoil and none during compression there would be still better riding?

JOHN WILKINSON:—I think that is true. On city roads, I cannot tell when there is a snubber on the car, but I have no doubt that on rough roads in the West that some such arrangement is almost a necessity.

ACTING CHAIRMAN COBLEIGH:—Is the winking action mentioned by Mr. Wilkinson a rocking of the whole car bodily?

JOHN WILKINSON:—Yes; the spring is clipped at the center, so that when the torque is exerted downward, the axle is moving around an arc.

ACTING CHAIRMAN COBLEIGH:—I think that in the that a shock is not felt as much on the back as on the front seat when going over an obstruction. Is that not largely due to the fact that the front wheel is pushing at the obstruction, so that more or less jamming must be provided for the front than for the back?

Locomotive Operation

JOHN WILKINSON:—That is true; and the effect is much more noticeable in the front than in the rear. When the New York Central Railroad first tried its electric locomotive a terrible accident occurred. The load was placed very low and then a car skids much more easily. The minute a car starts to skid, the rear wheel may hit something, and it turns over. On the Pennsylvania Railroad locomotives all the motors are carried high up in the cab, and they drive the wheels through a connecting-rod.

ACTING CHAIRMAN COBLEIGH:—I think that in the locomotives the low center of gravity did not produce greater skidding, but a pressure on the rails. That accident was produced by spreading of the rails on account of the side thrust going around a curve. The Pennsylvania Railroad motors are up in the air and connecting-rods are used so as to keep the locomotives from rocking.

JOHN WILKINSON:—But it is true that the low center of gravity will put much more pressure on the outer rail. One can imagine that the car tips so that the entire load is on the outer rail. In the same way when turning a corner a car with a high center of gravity skids less than one with a low center of gravity.

ACTING CHAIRMAN COBLEIGH:—It is said that owners of racing cars bind their springs with rope so as to get more attrition between the leaves and less spring action, and to make the car ride better for racing. It raises the question whether it is better for others. Of course, the conditions are quite different with a passenger car on ordinary country roads. Is it an advantage to bind the leaves together that way?

Then it is said to be positively wrong to lubricate the springs with graphite, and that a mixture of wax and rosin should be used. That would seem to agree with the idea of a rusty spring giving better riding than a well-lubricated one.

Racing-Car Suspension

JOHN WILKINSON:—With a car going at high speed, I would have the springs bound tightly; around town I like to have them oiled. One of our men rode in races for a number of years with all the springs bound; not to get easy riding, but to keep the spring from breaking on the rebound.

A MEMBER:—I think in that case the springs were not designed for racing. The ordinary springs did not suit the owner of the racing car, and he fixed them according to his own ideas.

A. K. BRUMBAUGH:—We cannot consider at all the easy riding qualities of a racing car. One or two that I was in at Sheepshead Bay rode almost like a truck.

ACTING CHAIRMAN COBLEIGH:—The suggestion has been made that in lubricating springs, kerosene be used first because that would seep its way in better and would make a way for the lubrication oil, so that that would afterward seep through; also that while it was not sightly, it was actually a good thing for the spring to let it get dusty.

STANLEY P. MCMINN:—In some cases, on a fairly rough road with many small bumps, the car will jar over the road or off to one side. I put on shock absorbers and eliminated that trouble.

I have ridden in racing cars with wrapped and unwrapped springs. The principal object is to increase the damping action, because the greater the speed the greater the blow and the greater the tendency for the wheels to slip, which means greater tire wear. If the damping action can be increased so as to keep the car down on the track, then some tire wear is eliminated. The wear on the tires depends largely on the generalship of the driver in keeping them on the road. A good driver will keep his tires on the road.

Change of Tires

W. C. KEYS:—One of the Cadillac cars gave considfabric tires and put on cord tires. The owner was then able to make around 60 m.p.h., and he thought the springs to make around 60 m.p.h., and he thought the springs had been altered.

We must consider the practical side of any suspension. On the Cadillac I was held down to a low clearance for commercial reasons. It was necessary to use comparatively stiff front springs, but the driver was far enough back from the front axle so that he was not shaken from the seat.

JOHN W. WATSON:—Ought the spring to be as soft as possible?

W. C. KEYS:—It depends upon the kind of driving. For limousines operated by careful drivers on city pavements I would make the springs very soft, but for racing I would want stiff and well-damped springs.

JOHN W. WATSON:—Should springs be stiff so as to be dampened on the recoil?

W. C. KEYS:—If the springs are very soft, the deflection must be large in order to keep off the bumpers; and that gives an action dangerous at high speed.

JOHN W. WATSON:—It is just as if the recoil is not dampened.

W. C. KEYS:—I ran a car that was rigged up on stilts (so to speak) at speeds of 40 m.p.h. over rough roads, but in my opinion that speed was not safe.

JOHN W. WATSON:—If the spring is rusty or stiff on the recoil, would it be better to have all that compression? Would not the car wave around so as to be dangerous?

W. C. KEYS:—I had the impression that the car rolled from one side to the other.

M. H. LANDIS:—If the springs are too stiff the hard riding qualities of the car will be increased on compression, because the hysteresis effect acts only when the springs are open. Suppose a car is jacked up, the load taken off the springs, and a certain load is put on it; and that load is taken off and put on again; then the more friction between the leaves the greater the hysteresis effect. The effect would be more noticeable with a spring with a greater number of leaves.

W. C. KEYS:—That can be taken care of by having the spring softer in the first place.

DAMPENING THE RECOIL

M. H. LANDIS:—Then is it not better to make the spring soft enough and provide a means of damping the recoil without interfering with the compression? Suppose that in going over a series of rough bumps the spring starts vibrating, the inertia of the car traveling in a straight line compresses the spring and raises the wheel off the road. When the wheel hits the road again, if the spring has started on its return movement, the tendency is to bend it that much farther. If the spring is too soft and flexible it hits bottom.

If the vibration can be thrown out of phase at the start of the recoil, can we not have all the desirable qualities obtained by having soft springs with a large range of movement? I saw that tested with soft wide springs with a small number of leaves. These were very flexible; so flexible in the front end with a 6-in. range of movement that with the car fully loaded in front one's hand on the radiator cap could start the whole car swinging.

When running at 20 m.p.h. the car hit bottom and bumped a great deal unless the recoil was controlled. At the same recoil without any compression of the spring we ran over the same roads at 30 m.p.h. without hitting bottom, for the reason that the vertical component of the thrust was not great enough to compress the spring fully owing to the range of movement present.

W. C. KEYS:—The ordinary automobile cushion is made up of coil springs mounted on a framework, with a pad of curled hair on top. A few years back most of them were closed over the bottom, except for vent holes; and if a newspaper happened to cover up those vents the passengers knew it the instant they sat down.

An experiment I tried was to seat two men on a properly upholstered cushion spring, leaving free the vent holes in the bottom of the cushion. The two men held onto each other and started bouncing up and down together; then suddenly I slipped some pieces of paper underneath so as to prevent the air from going into the cushion when the men were bouncing upward. This constituted an air snubber for cushions and most effectively checked the recoil. It was never worked out practically.

M. H. LANDIS:—We tried a similar experiment, holding the hand on the side of the car to observe the spring action and with the feet on the floor while the body was vibrating owing to the cushion action. I have ridden in some cars in which hard boards would ride better than the cushions actually in them. Some of the 10 or 12-in. cushions, if once started vibrating, would never stop.

ACTING CHAIRMAN COBLEIGH:—The point has been made about rust improving the riding qualities only on the recoil. If it also has an effect on the compression, the riding qualities improve after the springs are rusty because they get stiffer. If that is so, why not make them stiffer in the first place?

JOHN WILKINSON:—The spring does not ride more easily because it is stiffer, but in spite of its being stiffer.

Serration of Leaves

ACTING CHAIRMAN COBLEIGH:—The rust makes an improvement because it increases the resistance between the leaves. Why would it not be a good thing to have the leaves serrated?

JOHN WILKINSON:—We do not know just how much friction we need.

W. C. KEYS:—An automobile builder would not think of accepting springs that were not lubricated between the leaves.

ACTING CHAIRMAN COBLEIGH:—Suppose the serrations were round or wave-shaped, avoiding any thing sharp that is liable to start a crack.

JOHN W. WATSON:—The spring is stiffer then, and we want a softer spring. The reason that the rust does good is because it helps to check the recoil.

A MEMBER:—Suppose the spring had one leaf. Evidently, when riding on that, one gets quick motion. Suppose we put some kind of snubber on, say an arrangement with two plates pivoted at the top and bottom and a coil spring that would suffice to give friction alone. The deflection in pounds per inch might be the same as before, but friction and pounds per inch are two different matters.

W. C. KEYS:—I am satisfied, from a recent test, that a lubricated spring will give slightly better riding qualities on a good pavement. Many cars are driven only on pavements, and lubricated springs are a fair, all-round compromise under these conditions.

JOHN WILKINSON:—We formerly put coil springs on both front and rear in order to add to the supporting power of the springs. We would have a 160-lb. main spring and a 25-lb. coil spring, which made the total 185 lb. per in., but the effect was bad, and we had to abandon them. If we wanted the right effect we had to use a 185-lb. elliptic spring.

JOHN W. WATSON:—Do we want a softer spring for compression and then to check the recoil? Is it a fact that rust checks the recoil? Perhaps the dampening effect does good during recoil. We certainly benefit from it on the down thrust.

ACTING CHAIRMAN COBLEIGH:—Another thing we have had brought out is that for the same amount of metal in the spring, the more it is placed in the vertical relation the better. It is a case of compromise between the necessary width to get the necessary lateral stiffness. Otherwise, the narrower and deeper we make the spring the better. The main leaf has to be strong enough to stand all the load.

A MEMBER:—If there are too many plates the spring is not well balanced. The bending cannot be concentrated too much at certain points.

Vol. I December, 1917 No. 6

Tractor Lighting, Starting and Ignition

By Burns Dick* (*Member of the Society*)

Minneapolis Section Paper

THE one hundred and thirty different manufacturers of tractors in this country manufacture between them about two hundred varieties of tractors.

Engines used vary from one and two cylinders, having a bore of about 10 in., up to the eight-cylinder of 3¼-in. bore by 5-in. stroke.

Newer designs are being developed with four-cylinder engines having a normal speed of about 1800 r.p.m., and in which the general layouts follow more nearly those of accepted automobile designs; some will make use of electric lighting, starting, and battery ignition.

Strong appeals have been made lately by writers of authority for standardization of tractor design. The present condition resembles very much that in the early days of automobile development, when one never knew whether the engine was to be found under a hood in the front of the car, under the footboards in the center of the car, or in some out-of-the-way position in the rear.

Standardization means the creation of a wider market, since the necessary experience and knowledge for successful operation is then more general, because more frequently transmitted.

With the enormous variety of tractor designs now on the market it seems like putting a big job up to the accessory manufacturers to ask them to produce a standardized apparatus that will have a sufficiently wide range of application.

It seems that the question of standardization should be tackled seriously by the Society. One of the first steps that would help the manufacturers to realize the importance of any given design might be the organization of competitions under S. A. E. supervision; these would quickly eliminate some of the poorer features of present-day apparatus.

Even the small amount of semi-competitive work at tractor shows and demonstrations caused a comparatively large number of changes in design to be made, all tending toward the elimination of weaker points.

The development of the automobile was helped enormously in its earlier stages by competition in track and road racing; without such events the present high state of development would undoubtedly not have been reached for several years.

Electric Starting for Tractor Service

The advantages of electric cranking are practically the same for tractor as for automobile work. The best of drivers will occasionally stall their engines. In starting a furrow and getting the depth for plowing, there is always such a possibility; the knowledge that he can start the engine without having to leave his driving seat adds very much to the confidence and peace of mind of the operator. In fact, the addition of electric starting completes the centralization of the control.

On some tractors the location of the hand-starting crank is extremely awkward, and in others it necessitates considerable gearing. Personally, I would hate to have to crank by hand some of the large single-cylinder and two-cylinder engines, when they are being operated on wet or freshly plowed land.

When there are two operators to a tractor, occasional hand cranking may not be a serious disadvantage; but under present conditions one of the greatest advantages of tractors will be the possibility of one man being able to do the work previously requiring two; and it seems as though the general tendency in tractor design is to produce a machine that can be handled conveniently by one man.

Air Starters.—Farmers throughout the country are, in these days, well educated to the use of electric starters, and it would seem as though an attempt to use air or gas starters would be a step backward.

Air starters are comparatively cheap to construct, but it is difficult to maintain an air pressure over any great length of time.

Gas Starters.—In the days when compressed acetylene was in general use for lighting, the gas starter was a good compromise, in spite of the fact that it was only about 80 per cent efficient; and principally for that reason it is now out of date, since most people are now educated to starters that are practically 100 per cent efficient.

Combined Gas and Air Starters.—Under this heading are included the types using a mixture of air and gasoline vapor or acetylene. The efficiency of these is probably almost as great as that of electric systems, but the necessity for carrying a reservoir containing acetylene gas, and another with air under compression, and the devices necessary to give the proper mixture and distribution of the acetylene and air, probably introduce more complications than it is advisable to place in the hands of the average tractor operator. In addition to that, with any of the air or gas systems, the source of power for electric lights—one of the great advantages of the all-electric system—is not available.

Application of Starters and Generators

There appears to be no reason why the recommendations for generator and starter applications formulated by the Electrical Equipment Division of the S. A. E. Standards Committee should not be applicable to tractors. The flanges adopted seem amply wide to provide a thoroughly waterproof and dust-tight joint between generator or motor and the crankcase, and offer a good opportunity to make a start in standardization.

The design of the rest of the starter and generator is not different from usual automobile practice, except that special precautions should be taken to provide thoroughly dustproof commutator and bearing covers; and perhaps in some cases, where there is considerable overhang, extra reinforcement of motor and generator frames. The fact should always be kept in mind that the service will be much more severe, and the chances for skilled attention much less than has been the case in automobile service.

The necessity for frequent expert service will be largely offset by the establishment by the manufacturers of schools for the instruction of tractor operators. This movement is now making considerable headway.

The gears and gear ratio required, of course, will depend entirely upon the size and speed of engine to which the equipment is to be applied.

Dirt, vibration and neglect would probably be the chief causes of deterioration of motors and generators. Our experience has shown that the plain-sleeve type of bear-

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ing, with a large reservoir packed with cotton waste saturated with oil, is the most durable under such circumstances.

We have found that oiling is necessary about every 15 hr. in the case of ball bearings, while plain bearings will operate without lubrication for from three to four weeks, running 12 hr. per day.

Battery vs. Magneto Ignition

Successful starting and lighting is largely dependent upon a satisfactory battery installation; given a satisfactory battery, the use of battery ignition will naturally follow. There is no reason why magneto ignition should not be replaced by battery ignition, provided a source of current of fair capacity is available.

Special timers, distributors and coils should not be necessary, except that perhaps there should be some slight modification of the coil windings to provide a greater amount of energy at the spark-plug for starting with heavy fuels; but in this respect the battery system has inherently a great advantage over the magneto.

When using heavy fuels, a hot spark is most needed for starting. Battery ignition gives this naturally, and also a spark the intensity of which falls off at high speed. The high speeds usually mean a wide-open throttle, and under these conditions heavy fuels require a small amount of energy to ignite. This is parallel with the natural characteristics of battery ignition, but the reverse is true of magneto ignition.

All the other technical points so often aired in the discussion of magneto as compared with battery ignition seem to bear the same relation in the tractor problem as in the passenger-car problem. It is likely that the outcome will eventually be the same; that is to say, the general adoption of battery ignition.

Tractor Storage Batteries

The mass of information issued by the various manufacturers on the care of storage batteries shows that they need attention inherently. The most successful manufacturers of batteries for lighting and starting seem to be those who have most boldly faced the difficulties encountered and have made the most progress in educating the users.

The solution of the battery problem for lighting and starting of automobiles was a much greater achievement than will be required to use them successfully on tractors.

Nevertheless, the manufacturers insist that even better care will have to be taken of batteries used on tractors than has been the custom in the past with automobiles.

The manufacturers have designed special machines for subjecting batteries to artificial vibration, and in this way they have been able to produce cells specially suitable to the hard service required on tractors.

These special batteries are stated to be three times as strong as the average automobile starting battery as regards their resistance to destruction by vibration.

The mounting of the battery on a tractor is a problem that does not seem to have been satisfactorily solved up to date.

In one installation the battery was placed in the usual style of pressed-steel box, which was suspended by springs. This looked like a satisfactory installation when seen in the shop, but after a few hours' plowing it was noticed that the soil and mud thrown up by the lugs on the driving wheels had filled up a space of several inches beneath the battery box and the frame.

This is an example of the difficulties due to dirt that have to be contended with in tractor installations.

The ampere-hour capacity necessary will depend principally upon the lamp load and on the ignition current consumption. Probably an 80 to 100-ampere, 6-volt battery will take care of the average requirements. There does not appear to be any reason why any other than the standard 3-cell construction should be adopted, except perhaps in case of large engines. The requirements for cranking affect the size of storage battery only remotely, since with a properly designed starter the actual ampere hours drawn from the battery are extremely small. The break-away torque for starting is also a function of the starter and gearing design.

On some of the larger-sized engines one more pair of reduction gears may be necessary than is used in the present passenger-car practice.

Lighting Requirements

It has not yet been shown whether night plowing is practicable or necessary, for little of it has been done. This may be because up to date there have not been the necessary facilities. Electric lighting and starting will no doubt change the old-time methods just as much as the use of electric lighting and starting has affected the general use of automobiles.

Assuming the desirability of electric lights suitable for night plowing, we must first of all realize the great difference between the requirements of the tractor and of the average automobile. In automobile practice, a night speed of about 14 m.p.h. is assumed; and the illumination is usually arranged so that it will cover a distance ahead up to 200 ft., at least, and to some extent up to 500 ft. The distance ahead which it is necessary to illuminate is, of course, in direct proportion to the average speed, and since the speed of a tractor is a fraction of that of the automobile, we can consider that the lighting should extend over a range proportionately less.

The fair range of illumination for tractors is required at the ends of the furrows, and it is probable that about 50 ft. would be ample.

In practical demonstrations of night plowing, the use of three lamps has been found sufficient; two of about 16 cp. each, and one lamp of about 8 cp. The small lamp is used as the equivalent of the dashboard lamp; that is, to illuminate controls. One of the 16-cp. lamps is used in the form of a searchlight, supported by a universal swivel joint within reach of the operator, and the other 16 cp. to illuminate the plow or other implements. The latter is provided with a suitable shade to keep the light from the operator's eyes and to protect it from mechanical damage.

The use of high-grade lenses and reflectors seems unnecessary, but until special lamps have been developed for tractor work a plain parabolic reflector in which the bulb is slightly out of focus, so as to give a distribution of light over a wider angle, is satisfactory. The construction of the lamps and brackets must be much more substantial than is usual with automobile spot-lamps.

A lamp of this type, which is satisfactory when used on a passenger car, will go to pieces and cause short circuits after a few hours' use in tractor service.

No industry can progress that does not adopt promising labor and time-saving devices. Any device that enables a certain amount of work to be done in less time than was originally required is a step in the right direction. I insist that the use of electric lighting and starting on tractors is a time-saving device, and is therefore worthy of adoption.

Vol. I December, 1917 No. 6

Magneto vs. Battery Ignition

By J. A. WILLIAMS* (*Member of the Society*)

MINNEAPOLIS SECTION PAPER *Illustrated with* CHARTS

THE natural evolution of ignition in internal combustion engines from the hot tube to battery systems, then to the low-tension magneto and finally to the independent high-tension type of magneto, was accomplished through innumerable tests during the days of automobile engine development. These tests brought out the fact that the high-tension magneto gave best results and caused it to be universally recognized as the standard.

Efficiency in power production, fuel economy and reliability were sought after by the engineers of the automobile industry, and these things are exactly what the engineers of the tractor and the stationary gas-engine industry are seeking to-day.

Following the development of the automobile engine, the next demands on automobile engineers were for some means of starting and lighting automobiles. Mechanical starters and air-pressure starters were tried out and proved unsatisfactory; then the electric starting and lighting systems entered the field and have become universally adopted. These, however, not only add considerably to the first cost of the car, but also entail a considerable charge for its upkeep.

It is quite natural, therefore, that the car manufacturer sought means of decreasing cost in other directions in order to offset, in a measure, the added cost of electric starting and lighting equipment. With a storage battery as a source of current, one naturally argues, why not a battery ignition system? The result, especially among the popular priced cars, has been the general adoption of battery-ignition systems. The higher priced cars, however, mostly continue to make use of the independent high-tension magneto. The status as to battery ignition among passenger cars this year is that 58 models are using high-tension magneto ignition and 137 models are using battery ignition. Automobile trucks, however, almost universally are equipped with high-tension magnetos.

This change from magneto to battery ignition has given the general public the idea that the latter is just as good as the high-tension magneto ignition, whereas an analysis of the situation shows that the change was made for commercial reasons only.

In our engineering work we have always had in mind the great difference between conditions of automobile operation and conditions of tractor operation. The tractor resembles the automobile only to the extent that a gasoline engine, a transmission and differential are used in both cases, but there the comparison stops.

Automobiles are built of as light weight as possible, are run on pneumatic tires on good hard roads, carry comparatively light loads, and are equipped with engines of such size that they are probably operated for 95 per cent of the time at small throttle opening. They are rarely ever called upon to develop their maximum output of power, and even then but for a few minutes at a time; inasmuch as they are pleasure vehicles, very little thought or care is given to fuel economy.

Tractors, however, work nearly all the time under full load, operate steadily for hours at a time in dust and mud and run over plowed fields under all weather conditions. When not in use they are exposed to the rain and sunshine, heat and cold, and their operation is exclusively for profit and not for pleasure. This means that fuel economy and cost of upkeep are extremely vital points. Reliability of operation is not just merely hoped for, but is demanded.

COMPARISON OF SYSTEMS

For these reasons the designing of a high-tension magneto for tractor work cannot be based entirely upon the experience gained from the design of magneto ignition in the automobile field. This applies not only to the magneto ignition system, but practically to every other accessory and part used on a tractor.

This paper will discuss the principles of battery ignition and then describe high-tension magneto ignition. A comparison between the two types of ignition will then be given, and the paper concluded by illustrating diagrammatically how and why a hot spark causes the engine to produce more power and to economize greatly on fuel consumption.

Figs. 1 and 2 show all of the functional parts, not only of one battery ignition system, but of all of them, irrespective of their different arrangement of parts or outward appearance. The central core of soft iron wire in the spark coil is surrounded by, or wound with a primary winding of from 150 to 300 turns of insulated copper wire of comparatively large size and low resistance. The secondary winding, outside of and surrounding the primary winding, consists of a large number (usually from 20,000 to 30,000) of turns of fine copper wire. One end of this is connected either directly or indirectly to the frame work of the engine, and the other end to the terminal of the spark-plug.

The primary winding has a switch in the circuit, located at some convenient place not shown in the diagram, for turning the ignition on and off. The circuit-breaker, or interrupter, designated by the arrow heads in the diagram, is magnetically operated on the ordinary vibrating coil type and is mechanically operated on other types of battery-ignition systems.

The condenser connected to each terminal of the circuit breaker is composed of several sheets of tinfoil. The even-numbered sheets are connected to one terminal and the odd-numbered sheets to the other terminal of the condenser. These sheets of tinfoil are insulated from each other either by mica sheets or specially prepared paper.

There are in every ignition system two kinds of condensers, a good condenser and a bad condenser; the good condenser does the thing we want it to do, and is connected across the terminals of the circuit breaker or interrupter. The bad condenser does the thing we do not want it to do, and is located within the secondary winding of the coil; it is called technically the static capacity of the secondary winding.

Inefficient ignition systems have a large bad condenser, or a great deal of static capacity in the secondary winding. Good ignition systems have a small bad condenser, and consequently much less static capacity in the secondary winding.

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The storage battery simply acts as a source of current. The iron-wire core directs the magnetic lines of force created by the current circulating through the primary winding.

Function of Battery-Ignition Parts

The function of the primary winding is to form a path so that the electric current can circulate, many times, around the iron-wire core and thus produce the magnetic lines of force in the core.

The function of the secondary winding is to generate a high voltage anywhere from 20,000 to 30,000, so that whatever current the coil delivers will jump the gap in the spark-plug.

The function of the circuit-breaker, or interrupter, is to break the circuit and interrupt the flow of current when the current circulating around the core has reached its predetermined or ultimate value.

The function of the good condenser is to absorb the current that forms an arc across the gap caused by the separation of the circuit-breaker points. It is surprising what a large amount of current a small condenser will absorb.

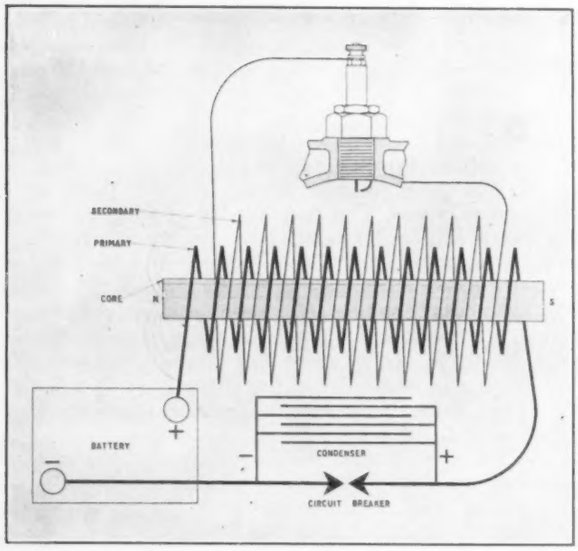


Fig. 1—Cross-Sectional View Showing Functional Parts of Battery Ignition System

The capacity of a condenser depends upon two things; first, the area of metallic surfaces opposed to each other; second, the nearness together of those surfaces. In other words, the larger the surfaces involved and the closer together they are, the greater the capacity of the condenser to absorb current.

It is important in any ignition system to have a condenser of just the right capacity to absorb the current and stop the sparking at the circuit-breaker points. The points, however, must be allowed to spark a little, just enough to keep themselves burnt clean.

The function of a spark-plug is simply to create a gap in the cylinder of the engine for the spark to occur in. This gap should be of the proper width to absorb the maximum energy that the ignition system will produce.

Effect of Static Capacity

It might be well, at this time, to explain the function of what we call the bad condenser, which insists on being present in every ignition system. This bad condenser is located along every inch of wire of the secondary winding. The longer the wire in the secondary winding, and the more turns it has, the greater the capacity of the bad condenser. This absorbs the current, thus preventing the spark from being as hot as we would like to see it.

Fig. 3 illustrates further the action of the bad condenser, or the static capacity of the secondary winding. This shows three different lengths of water pipe, connected together at one end to a larger pipe, which is kept full of water. These pipes have the same size holes drilled in them, and the same number of holes per inch-length of pipe. Instead of running through the pipe the water leaks through the holes thus created. Very little water comes from the end of the longest pipe. Nearly all of it leaks away through the small holes. A greater quantity of water flows from the end of the next longest pipe. The shortest length of pipe has the greatest quantity of water flowing from its end.

Just imagine that these pipes are the secondary windings of different types of ignition systems, that the end of the pipe is the spark-plug gap, and that the amount of water flowing from the ends corresponds to the current flowing across the spark-plug gap. Also that the water leaking from the small holes represents the current that is being wasted by the bad condenser, or static capacity of the secondary winding.

We will then realize how the secondary winding of an ignition system acts as a condenser and wastes the current that we would like to get at the spark-plug gap for ignition purposes. We will further see that the shorter we can have this secondary winding and still generate the voltage required to jump the spark-plug gap, the more current we will have left to create heat in the spark.

We can compare these different lengths of water pipe, Fig. 3, with three different types of ignition systems, as follows: The longest pipe to a battery-ignition system; the next longest to the old style or H armature type of high-tension magneto, and the shortest pipe to the most efficient design of high-tension magneto.

In the operation of a spark coil, current flows around the turns of the primary winding when the circuit-breaker closes, building up lines of magnetic force in the iron-wire core. Next the circuit-breaker points open, causing the current that built up the lines of force to cease flowing. The lines of force in the core of the coil then disappear, but in a much smaller period of time than it takes to create them. By disappearing they create electrical pressure in the turns of the secondary winding. This cycle of operation is repeated every time the circuit-breaker points close and open.

The action of a battery ignition system is just like lifting up a hammer and letting it fall on a nail. The only force applied to the nail is the power that the hammer exerts through its weight in falling. This is rather an inefficient way to drive a nail, is it not? We have no means in a battery-ignition system to handle the lines of magnetic force any more energetically than to let them fall, just as the hammer falls on the nail.

The height to which the hammer is raised can be compared to the number of lines of magnetic force built up in the iron-wire core, and their speed of disappearance compared to the force of gravitation that brings the hammer down.

Half of the magnetic circuit of a spark coil is the air.

The lines of force produced in the core of the coil have to travel through the air from one end of the core to the other.

Magnetic Circuit Inefficient

Air offers something like 280 times the resistance to the flow of magnetism as does iron, so that a battery-ignition coil has an inefficient magnetic circuit, requiring a strong current of electricity circulating around the iron-wire core in order to produce a few lines of magnetic force.

The question might be raised as to why it would not be good construction to lengthen the iron-wire core and join its two ends together in a ring, so that it would have a path of high magnetic conductivity in which a small amount of electrical energy could produce a large number of magnetic lines of force.

The reply to this question would be that it would then take a long time for the electric current to rise to its full value, owing to the largely increased induction in the coil. Furthermore, after having raised the magnetism to the highest obtainable value, it would disappear very slowly, on breaking the circuit, for the lines of force in the core of the coil by their very generation create an opposing voltage, which tends to oppose the battery voltage and prevent its rapid rise to a maximum.

Spark coils for battery-ignition systems must be made with straight iron-wire cores, in order to secure sufficient rapidity of action, consequently they must of necessity have an inefficient magnetic circuit.

If we could double the rapidity with which we vary the amount of these lines of force; or, if we could double the quantity of lines of force, we could then get along with half as many turns of wire on the secondary winding.

The effect of this shortening of the length of the wire in the secondary winding would be the cutting in half of the static capacity, or the absorption of current by the secondary winding, consequently doubling the current delivered at the spark-plug points without decreasing the voltage.

The more volts that we can make one turn of secondary winding produce, the less surface we expose to absorption of the current produced and the larger the output of energy we get at the spark-plug points.

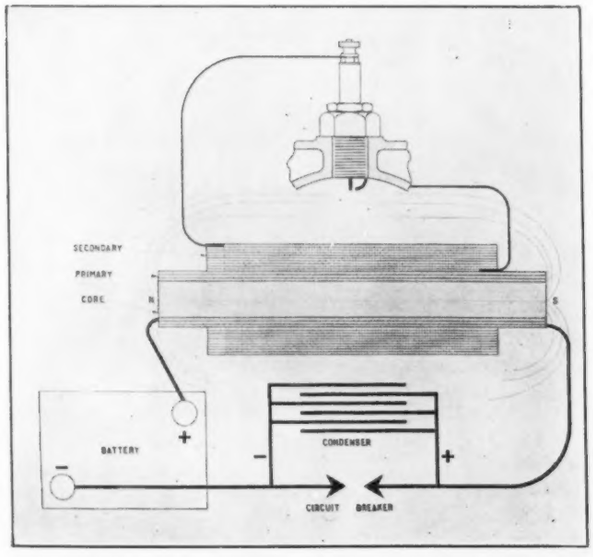


FIG. 2—SECTION OF COIL USED IN BATTERY IGNITION SYSTEM

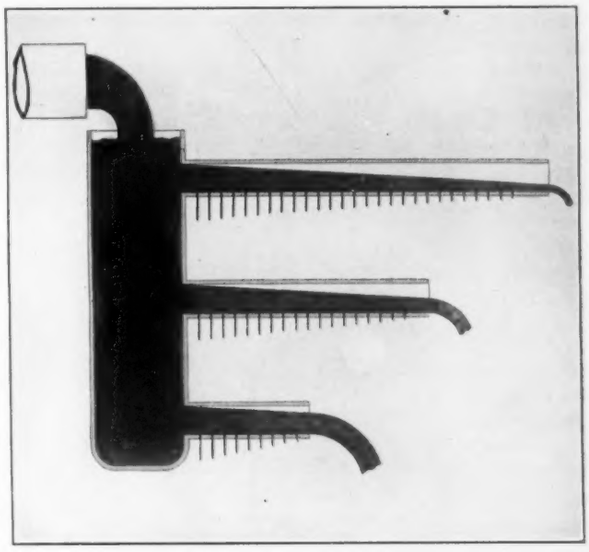


FIG. 3—GRAPHIC REPRESENTATION OF STATIC CAPACITY OF SECONDARY WINDING

In a battery-ignition system we are compelled, on account of the limitations imposed by the speed of operation, to use an inefficient magnetic circuit, which generates a comparatively low voltage per turn of secondary winding. A large number of turns is required and a large surface must be exposed to the absorption of current through static capacity, resulting in the production of the skeleton of a spark at the spark-plug points, leaving the meat of the spark to be absorbed in the secondary winding.

In battery-ignition systems we find inherent faults as follows: First, they do not and cannot create enough lines of magnetic force. Second, they do not and cannot handle, with sufficient energy or speed, the few lines of magnetic force they do create.

In consequence of these two faults they cannot generate sufficient voltage per turn of secondary winding.

Inasmuch as a low-tension magneto simply acts as a source of current and a circuit-breaker and uses the same kind of a spark coil as does a battery ignition system, it does not produce a much better spark; it is, however, a much more reliable source of current.

If we can design an ignition system with all of its magnetic circuit composed of soft iron or steel, the result will be a very efficient magnetic circuit, thus permitting the generation and handling of a large number of lines of magnetic force. We must, however, have means for causing the rapid disappearance or reversal of these lines of force.

PRINCIPLES OF HIGH-TENSION MAGNETO

Let us look into the principles employed in the high-tension magneto, to see whether that device remedies any of the defects existing in the spark coil of a battery-ignition system.

Fig. 4 illustrates the working principle of a modern high-tension magneto, which is used largely in the tractor and stationary gas engine fields.

It consists of a soft iron core, a primary winding surrounding it, a secondary winding outside of the primary winding, a circuit-breaker and a condenser; or of every

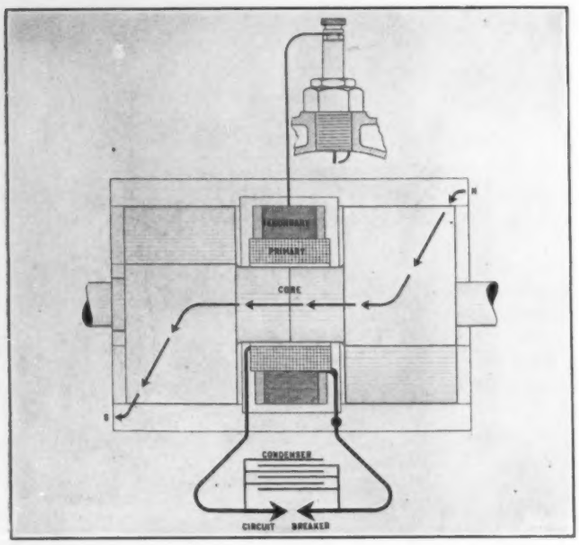


FIG. 4—WORKING PARTS OF MODERN HIGH-TENSION MAGNETO

functional part used in a battery-ignition spark coil.

Instead, however, of a storage battery we have permanent magnets. The permanent magnets are not shown in Fig. 4, as we are looking up from the bottom of the magneto so as to get a better view of the windings and core.

The core of the armature, which is the core of the winding, is round and stubby. It has two extensions on each end, so as to conduct the lines of force, from the pole pieces of the permanent magnets to the core of the winding, through the core of the winding and out at the opposite pole.

This core of the winding is located in the direct path of flow of the greatest number of lines of force from the permanent magnets; being made of the softest iron, it forms a good conductor, thus concentrating all the lines of force of the permanent magnets and conducting them to the center or axis of the winding.

The secondary winding is very short, because a large number of turns and a great length of wire are not necessary in this design.

The pole pieces, instead of being set directly opposite each other, have their centers spaced 90 deg. apart. The extensions of the armature core or rotor are also set 90 deg. apart, so as to conform to the location of the pole pieces of the permanent magnet. The shortest possible path thus exists for the magnetic lines of force to go from pole piece to pole piece, and at the same time to make all of them pass through the center or axis of the winding.

Fig. 5 is an end view of the same magneto; the air gap in the circuit is just as small as will permit of a safe running clearance of the rotor or core extensions.

In comparing the construction shown in Figs. 4 and 5 with that of the spark coil of a battery ignition system, we see that we have enormously shortened the core of the coil, and in addition have almost entirely eliminated the long high-resistance air path of the battery spark-coil, thus providing an easy path for a large number of magnetic lines of force.

Now let us see how we can compel the rapid disappearance of this large number of lines of force by reversal of polarity, thus not only handling a greatly increased number of lines of force, but also handling them at least twice as energetically as could be done with the battery ignition coil.

Outline of Operation

Fig. 5a shows the rotor or core at rest. The magnetic lines of force are coming down through the wing of the rotor, are passing centrally through the round core and round winding, and are going up the core extension on the other side of the winding to the opposite pole of the permanent magnet.

In Fig. 5b the armature is shown in a different position, just as it is being rotated to the next position. Fig. 5c shows the rotor in position that it occupies during the time that a spark is being delivered to the spark-plug. The arrows are going into the core on the opposite or further side of the winding, then through the core, passing out on this side of the winding, showing that we have a complete reversal of polarity through the winding.

Summing the matter up in a few words: A modern high-tension magneto corrects the inherent defects in a battery ignition system. It handles a much larger number of lines of force, the reversal of polarity increasing their rate of change.

This is doing just what will cause the generation of a higher voltage per turn in the secondary winding, thus permitting the use of a much shorter secondary winding, consequently exposing much less surface of wire to the action of absorption of current by static capacity and cutting down the opportunity of the so-called bad condenser to rob the spark-plug gap of the current necessary to give the greatest spark heat.

Referring to the hammer and nail illustration, with the high-tension magneto, we can raise the hammer to a much greater height and we can slam it down with a great deal of force, thus driving our nail efficiently and quickly.

Having shown why a battery-ignition system produces a weak spark, and a high-tension magneto system a hot spark, it remains to be shown how and why the hot spark will cause an engine to produce more power with less fuel consumption.

Heat of the Spark

Opinions among engineers differ greatly as to whether

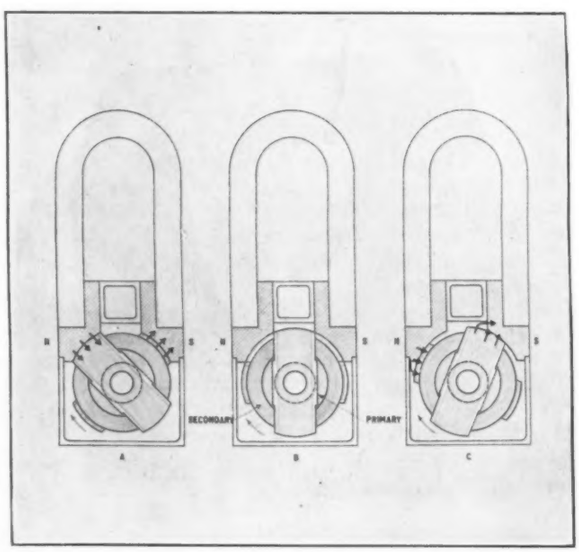


FIG. 5—MAGNETIC FLUX AT DIFFERENT POSITIONS OF MAGNETO ROTOR

a hot spark is any better than a weak spark. Some of them seem to think that a spark is a spark, and so long as it does not make a missed explosion we are getting all out of it that is possible. Nothing is further from the truth than that assumption. In practice we find that the weaker the spark is the slower the propagation of flame in the mixture, necessitating a much greater advance to the spark. Further the hotter the spark the less early must it occur in advance of dead center, for there is a direct relation between the heat of the spark and the speed of flame propagation in the mixture.

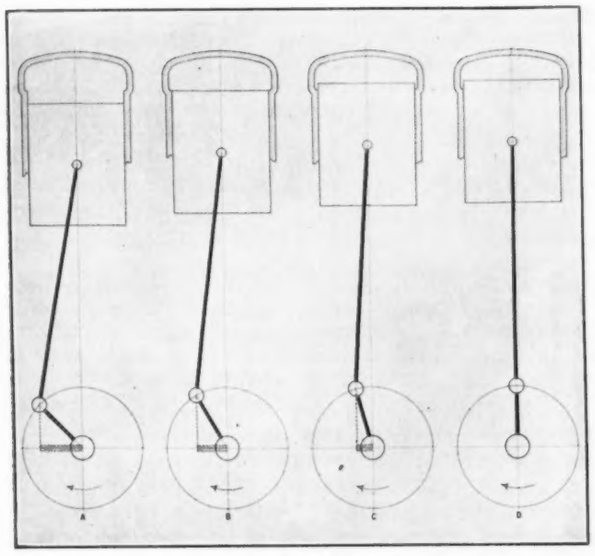


FIG. 6—POWER LOSSES WITH SPARK OCCURRING AT DIFFERENT POSITIONS IN STROKE

Fig. 6 shows four different positions of an engine cylinder, piston, connecting-rod and crank throw.

The spark is supposed to be occurring at all these different positions. Fig. 6a shows the spark advanced farther than in any other diagram. This represents the engine firing with a weak or battery-ignition spark.

Note the shaded area projected down from the center of the crankshaft. This represents negative torque, or power using up fuel in an effort to run the engine backward.

Fig. 6b represents the engine firing with a still hotter spark, and consequently with less spark advance needed. The negative torque is now smaller, showing less fuel burned and less power expended in the wrong direction.

Fig. 6c shows the engine in operation with a hot, powerful, high-tension magneto spark, which is occurring still nearer dead center, wasting less fuel, generating more power in the forward direction and burning less fuel.

Fig. 6d represents the ideal condition, which we have not yet attained, but which we will attain just as soon as we can create ignition sparks as hot as they should be. If we can get an ignition spark sufficiently hot and large, the propagation of flame through the mixture will be so fast that we will not have to begin to ignite the mixture a long way ahead of dead center, as we do now, with the weakest sparks.

I cannot see how any one can doubt the greater value of a hot spark over a weak one. Suppose one were going to kindle a fire in the stove or grate and wanted to have it burning briskly within the shortest possible time; would it not greatly facilitate matters if plenty of good kindling were used and if that kindling were lighted all over and at once with a hot blow-torch flame?

In the cylinder of a gas engine we are kindling a fire. In a high speed engine we must kindle that fire and burn up all the fuel in an inconceivably short space of time.

We are constantly doing a great amount of research work in our laboratory, and we believe that this ideal spark is not only a possibility but a probability. All the results obtained from our experimental data and research work lead us to believe that we are working in the right direction.

In conclusion, since we have seen that the modern high-tension magneto not only gives now but promises for the future so much better results than any type of battery ignition, is it not the part of wisdom for builders of engines to cleave to and encourage the development of that system of ignition which promises ultimately to solve their ignition problems properly?

LIBERTY ENGINE SUCCESSFUL

It is understood that the tools and jigs have been completed so that the Liberty airplane engine is now in commercial production. Many rumors are abroad concerning this engine, some favorable, referring to it as a miracle, and others dark and dismal, telling of it as a collosal failure. It is said that the latter rumors have been started for a purpose, however, but that the sources have been found, and that they will not continue to be circulated much longer.

The men who have been in touch with the design and development of the engine look at it neither as a miracle nor a failure, but as a remarkable achievement, which is giving better results on the block and in the air than any other engine the performance of which is known in this country. The engine has been operated at unusual altitudes, developing at the higher levels surprisingly high power; it has developed on the ground more horsepower on less fuel—an item of tremendous importance in aircraft—than any aircraft engine of foreign make for which we have any data. The American engine develops 100 hp. more than certain engines which lately have been considered excellent abroad, in 100 pounds less weight, and on less fuel. It has run continuously for days at a time on full load with nothing to do to it after the day and night runs but to wipe the stray oil off the outside.

The present conclusion of those in touch with the situation is this: The Liberty engine will require months of service before it is really developed to near-perfection. It must grow in detail under the lessons learned over the lines abroad. It is fundamentally right, however, and capable of quantity production by our fast American methods. This advantage alone is sufficient to indicate why an attempt to copy a foreign design would have been a slow and foolish undertaking.

At present only generalities can be used in referring to the design; this is no time to print facts bearing on our air program for the enemy to gage results by, and plan to meet. But it is believed this can be taken as definite: The Liberty engine, as it now stands, is a complete success. It may not be the principal engine in production a year from now, because we are learning so fast. While it is in production, however, any improvements in construction to be had will be embodied.

Current Standardization Work

THE Standards work for the year has practically been completed, although a number of divisions will probably meet early in January to clean up the final details of their work. A meeting of the whole Standards Committee will be held on Jan. 9, the day preceding the Annual Meeting of the Society. Division meetings held last month included a two-day meeting at Dayton of the Aeronautic Division, one of the Tire and Rim Division at Detroit, several meetings of the Lighting Division in conference with State officials and others interested in the elimination of glare, a meeting of the Tractor Division early this month in Minneapolis, and finally an important conference at which the subject of landing wheels for airplanes was discussed by a committee cooperating with the Aeronautic Division.

Aeronautic Division Meeting

Aeronautic standardization was considered at a meeting held Dec. 2 and 3 at Dayton, Ohio. The following were present: Chairman Charles M. Manly, F. W. Caldwell, Clarence Carson, Captain de Chanvalon, J. V. Costello, E. H. Ehrman, T. H. Huff, L. D. Kent, C. B. King, W. S. James, J. B. Johnson, F. C. Luncke, J. G. Perrin, Harry Russon, Major J. G. Vincent, A. N. Wilson, W. S. Wolfe, and Standards Manager M. W. Hanks.

Screws and Bolts.—The division has recommended a 12/32 screw thread in place of the 12/28, which is the A. S. M. E. standard. The finer thread has been adopted in aeronautic practice on account of its giving more strength to the bolt and of its being less liable to become loose. The Navy Department has asked why the A. S. M. E. standard was not followed. At the present time the aircraft builders have all adopted the 12/32 so that the fine thread is in general use.

Nut Chamfer.—The International Aircraft Standards Board has decided to omit the chamfer on plain and castle nuts smaller than ¼-in. diameter. This was considered by the meeting and it was decided that there was no real reason for the division to follow this practice and that further information should be secured from the I. A. S. B. before making any change.

Plain Washers.—A report was submitted by E. H. Ehrman giving dimensions for airplane bolt washers for sizes up to 4-in. diameter. These dimensions are shown in the accompanying table, which is published in order to obtain constructive criticism for the benefit of the Division. It is especially desired to learn what load the large washers for wood will stand, how much they will be depressed under load, and to what extent spruce and ash will be depressed when these washers are subjected to load. Comments are also desired as to the commercial tolerances of thickness, diameter and hole size.

Propeller Shaft-Ends.—It was understood that Major Vincent would submit drawings of the different sizes of propeller-hubs developed by the Aviation Section together with an explanation of the use to which these hubs are to be put. This information will be considered by the members of the division in order to standardize the different sizes.

The meeting closed with a discussion of the methods by which the Aeronautic Division and the Aviation Section of the Signal Corps should cooperate in formulating standards. Major Vincent suggested that it would be well to have the engineers representing the different factories in the industry hold meetings regularly at Dayton once a month, at which any action taken by the Airplane Engineering Division of the Signal Corps could be discussed and any recommendations made to improve them.

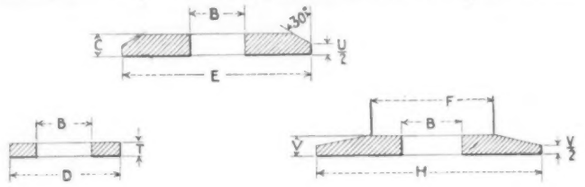


TABLE OF AIRPLANE BOLT WASHER DIMENSIONS

Bolt Size	All Styles	Small for Steel		Medium		Large for Wood		
	B	*D*	*T*	*E*	*U*	*H*	*F*	*V*
6	#26 (0.147)	5/16	20	7/16	20	1/2	5/8	18
8	#17 (0.173)	7/16	20	1/2	20	5/8	5/8	18*
10	#8 (0.199)	1/2	20	9/16	18	3/4	7/16	18
12	#1 (0.228)	1/2	18	5/8	18	7/8	1/2	1/16
1/4	17/64	9/16	18	3/4	18	1	1/2	1/16*
5/16	21/64	5/8	18	7/8	16 (1/16†)	1 1/4	5/8	5/64
3/8	25/64	3/4	18	1	16 (1/16)	1 1/2	3/4	5/32*
7/16	29/64	7/8	1/16	1 1/4	14 (5/64)	1 3/4	7/8	1/8
1/2	33/64	1	1/16	1 3/8	12 (3/32)	2	1	1/8*
9/16	1 9/32	1 1/8	5/64	1 1/2	12 (3/32)	2 1/4	1 1/8	5/32
5/8	2 1/32	1 1/4	5/64	1 3/4	10 (1/8)	2 1/2	1 1/4	5/32*
11/16	2 5/32	.....	.....	.....	.....	2 3/4	1 3/8	1/16
3/4	2 9/32	1 3/8	3/32	.....	.....	3	1 1/2	1/16*
7/8	2 9/32	1 1/2	3/32	.....	.....	3 1/2	1 3/4	3/32
1	1 1/32	1 3/4	1/8	.....	.....	4	2	1/8*

W. & M. Gauge	*20	*18	*16	*14
Equiv.	0.0348	0.0475	0.0625	0.0800

*Abbreviated series—used if product is press work. †Optional thickness.

The suggestion was also made that the aeronautic standardization work should be laid out so that there will be no duplication of effort by the S. A. E. Standards Committee and the International Aircraft Standards Board.

Landing Wheels for Aircraft

A meeting was held Dec. 11 in Cleveland to formulate specifications for the testing and construction of the airplane landing wheels previously recommended to the Signal Corps. The following committee of the Aeronautic Division was present at the meeting: F. A. Aspell, C. E. Bonnett, F. E. Castle, J. V. Costello, J. C. Ferguson, L. A. Frayer, C. W. Gressle, Albert J. Hall, A. Hargrave, O. H. Jobski, F. J. Johns, Jr., E. Frost Knapp, H. E. Krause, H. W. Kyte, M. A. Marquette, H. C. McMahon, William L. McGrath, Mark Merriman, W. Messinger, J. C. Monteith, O. W. Mott, G. W. Mowry, Alfred J. Poole, B. A. Quayle, Frank A. Stover, H. B. Walker, E. T. Walling, A. N. Wilcox, J. Robert Wilkins, W. S. Wolfe, and Standards Manager M. W. Hanks.

The first step taken was to form subcommittees to consider specific subjects. Four of these were designated as follows: Tires and Tubes, Rims, Spokes and Nipples, and Hubs. The Tire and Tube Subcommittee, consisting of Messrs. Hargrave, Johns, McMahon, Marquette and Wolfe, presented a specification for tire con-

struction which does not include the testing specifications for the tires. It is believed that a large number of tires should be constructed before it will be possible to determine the correct limits and pressure to make the tests.

Tires for Airplanes

The specification for airplane tires as submitted is as follows:

General Weights and Dimensions.—Airplane tires shall be free from defects and guaranteed as to material and workmanship. The tires must be of smooth cut. They should be branded with both the manufacturer's name and serial number and date of manufacture. The tires shall be branded with the metric sizes and rim size which they fit, as shown in the accompanying table. The tires shall be of clincher type and conform with the dimensions and weights shown in the table:

Size	Rim	Inflated Sec. Dia. Max.	Inflated Sec. Dia. Min.	Max. Weight lb.	Max. Weight oz.	Min. Weight lb.	Min. Weight oz.	Min. Tread Thickness	Max. Side Wall Rubber
700 x 75	W_1	3 1/16	2 7/8	5	5	4	11	1/16	1/32
700 x 100	Z_2	4 1/16	3 7/8	9	2	8	8	3/32	3/64
750 x 125	Z_2	5 1/16	4 7/8	11	2	10	4	3/32	3/64
800 x 150	Z_3	5 15/16	5 3/4	13	4	12	6	1/8	3/64

Enough compound must be put on the side wall to protect the fabric. The section diameters are to be measured at 50-lb. inflation pressure. The weights of the tires given in the table do not include that of the flaps. The specific gravity of the tread stock shall not exceed 1.30.

The beads must be so designed as to fit properly rim contours designed in accordance with rim templates provided by the Tire & Rim Association.

The rims on which these tires are to be used must be inspected according to these templates, and must bear the stamp of approval of the Tire & Rim Association. The brand must be put on at the final inspection after the rim is laced into the wheels.

The inside of the tire shall be properly painted in accordance with the standard practice of regular automobile-tire manufacturers.

Construction.—Tires shall be constructed of two or more plies and of cords of best quality cotton, so that an equal number of plies run in each diagonal direction across the tire; or of a suitable number of fabrics plies. When the former construction is used, the cords in any one layer must be separated from each other by a thin coat of rubber. Each ply shall be separated from each other ply by a thin skim coat of rubber.

The beads must be so constructed as to insure the inner tube against pinching. This may be accomplished by use of a flap cemented onto the bead by a suitable reinforcement on the under side of the inner tube.

Landing-Wheel Rim

The Committee on Rims recommended that orders now placed should come through with the old analyses, but that the analysis for any new rims should be as follows: Carbon, 0.18 to 0.25; manganese, 0.35 to 0.55; phosphorus, 0.05; and sulphur, less than 0.05 per cent.

It was reported that gages are being designed for measuring the contours and diameters for the various rims.

Hubs, Spokes and Nipples

A joint meeting was held by the committees interested in hubs, spokes, and nipples. It was recommended that the hub dimensions for 1¾-in. nominal axle size should be 7 in. overall length and that the tubing should be 2 1/16 in. outside diameter and of No. 16 B.W.G. gage. The hub dimensions for 2 and 2 3/16-in. nominal axle sizes are suggested to be 7¼-in. overall length with tubing No. 16 B.W.G. gage of 2½-in. outside diameter.

There was considerable discussion as to whether seamless or electrically welded tubing should be used for these hubs. It is said that the former is difficult to obtain whereas the electrically welded tube can be secured easily and is amply strong for the purpose, since the hubs are not subjected to excessive strain. Seamless tubing was therefore recommended by the joint committee.

The swedge type of spoke was recommended with the body portion 0.104-in. diameter, swedged down to 0.090 in. The length of the body portion at the head is 1¼ in. and at the threaded end 1¾ in., ½ in. being devoted to the thread. It was suggested that a 56 pitch be used but finally this matter was referred to the same committee that made a study of the spoke threads for motorcycles.

A recommendation was made that the same physical tests, with the exception of that for tensile strength, which is a factor depending on spoke diameter, be used as provided for the motorcycle specifications and also that the chemical contents be the same. The specifications for landing wheel spokes are as follows:

Spoke Wire.—This shall have the following chemical contents within the limits specified: Carbon, 0.40 to 0.55; manganese, not over 0.50; phosphorus, not over 0.05; and sulphur, not over 0.05 per cent. The nominal wire diameter must be 0.104 in. plus 0.000 or minus 0.001 in.

Bend Test.—The wire must be held firmly in a pair of jaws so that it can be bent over a surface having a radius of one-half its nominal diameter. It should stand a test of at least four bends, counted as follows: First, the free length of the wire should be held loosely between clamps so that it cannot bend except at the holding jaws. It is to be bent 90 deg. over one jaw, this being counted as one bend. It is then to be bent to its original position, which is supposed to be counted as a second bend. It is next bent 90 deg. to the other side (third bend) and back to its original position to complete the test.

Tensile Strength.—This is to be not less than 140,000 lb. per sq. in.

Nipple Stock.—This is to be a free-cutting screw stock.

Spoke Dimensions.—(a) General dimensions and tolerances of finished spokes shall be according to the drawing submitted by the Signal Corps.

(b) The thread tolerance will be determined by the Miscellaneous Division of the S. A. E. Standards Committee and will show the tolerance without plating.

(c) The process of making threads (as to whether they should be cut or rolled) is to be determined.

Nipples.—The nipple is to be finished according to a drawing to be furnished by the Signal Corps.

Lighting Division Meetings

The Lighting Division has been instrumental in bringing about two meetings during the month of November for the purpose of studying head-lamp illumination.

On Nov. 15, at the S. A. E. headquarters, New York, a joint meeting of the Lighting Division was held, with officials from a number of Eastern States. This meeting followed a suggestion from the National Automobile Chamber of Commerce. Those present were: John A. Macdonald, Olin H. Chase, Robert A. Brannigan, G. W. Brusstar, James A. Hemstreet, A. L. Atwood, Michael M. Van Buren, George R. Wellington, Francis M. Hugo,

William L. Dill, Fred. Kuser, Albert S. Olsson, Garrett L. Sealey, William T. Jones, C. E. Godley, Paul F. Bauder, A. Ludlow Clayden, Herbert Chase, R. S. Burnett and Standard Manager M. W. Hanks.

It was the opinion of P. F. Bauder that to obtain a meeting of minds it would be best to specify the essential head-lamp features as follows:

Head-lamp.—The essential features of a head-lamp are: A true parabolic reflector, a clear, incandescent lamp bulb, clear front glass, and a distance from the lamp centers to the ground of not less than 3 nor more than 4 ft.

Light.—With a true parabolic reflector and a clear front glass, the reflected light is of much greater importance than the direct and diffused light.

Illumination.—Both the illumination of the road and above the road should be considered. The sense of the meeting was that the side illumination would be ample if the S. A. E. specifications were followed.

Head-Lamp Illumination.—Three viewpoints, of the driver, the driver of an approaching machine, and the driver of an overtaking machine have been considered in formulating the following specification:

The head-lamp shall be arranged so that no portion of the reflected beam cone of light shall rise above 42 in., when measured 75 ft. ahead of the head-lamps, from the level surface of the road on which the vehicle stands under any condition of loading; nor shall any portion of the reflected beam cone of light beyond the 75-ft. distance rise more than 12 in. above the center of the head-lamp.

In order to insure sufficient illumination to render visible ordinary objects on the road 200 ft. or more ahead of the car, the intensity of the light at 75 ft. directly in front of the car, and not less than 30 in. above the surface of the road shall be with both head-lamps burning, under ordinary driving conditions, not less than (a number which is to be determined) foot-candles.

At present, various State laws merely specify that objects shall be rendered visible by the illumination from the head-lamps. Visibility, however, is an indefinite term, and its specific value should be used in defining the illumination intensity necessary to discern objects at 200 ft. The Automobile Head-lamp Committee of the Illuminating Engineers Society is to determine this factor.

Testing Apparatus

On Nov. 28 the Lighting Division held a joint meeting with the Automobile Head-lamp Committee of the Illuminating Engineering Society. Those present were: Dr. Percy W. Cobb, E. C. Crittenden, Evan J. Edwards, C. A. B. Halvorson, W. F. Little, W. A. McKay, J. S. Marvin, Dr. C. H. Sharp, R. S. Burnett, and Standard Manager M. W. Hanks.

It was the opinion of those present that the apparatus for testing head-lamp illumination should be arranged as follows:

Conditions.—A dark night on a level country road having a medium dark surface.

Equipment.—Two pair of 9-in. head-lamps having parabolic reflectors; 16-cp. clear, incandescent lamps, larger if necessary, accurately focused and clear, plain front glass. It was decided that the head-lamps should be mounted on a seperate stand, but placed in relatively the same position as they would be on the car, so as not to have the car-loading error affect the beam cone of light during comparative readings. The tops of the light openings should be 42 in. above the surface of the road and the centers should be 42 in. apart.

The electrical circuit provides for two 7 or 8-volt, 16-cp. lamps, to be placed in parallel, and controlled by a rheostat in series with 260 ft. of No. 16 lamp-cord. This length of lamp-cord is necessary to run from the observer's car to the head-lamp of the approaching car 250 ft. away. Current is to be supplied by two 160-amp.-hr., 6-volt storage batteries, connected in series. The rheostat will introduce enough voltage drop so that the 7- or 8-volt lamps can be properly controlled. The rheostat should have enough points of contact to avoid marked changes in the intensity of the light.

As the glare from the head-lamps of the approaching car is influenced by the amount of light from the driver's car, the test for discerning objects or "observation tests" will be taken first, and this same light should be on the road when glare test is made.

Ordinary objects on the road, such as a man dressed in dark clothes 250 ft. in front of the car, should, according to New York State laws, which are similar to those of many other States, be revealed to the car driver by the light from the head-lamp. As visibility is entirely a question of visual sensibility, it is believed that a tangible factor can be obtained only by averaging opinions of hundreds of observers and recording the actual light falling on the object at the time the observer was able to see it.

To obtain readings on the light intensity necessary to reveal a man 250 ft. in front of the car, or less if so desired, the lamps are first dimmed and then brought up to such an intensity as will reveal the man. The intensity in foot-candles is then recorded.

Glare Test.—One pair of test head-lamps is set up on the road 250 ft. from the observer's stand. The eyes of the observer should be at the same height above the road as those of the average driver. The test head-lamp will be controlled from the observer's stand so he can dim the test lamps to a point where the glare would not, in his opinion, be seriously objectionable in passing. When the adjustment is made the intensity of light in the observer's eyes should be recorded. The direct rays can be diverted or dispersed so as to change the intensity of the beam cone of light without changing the color.

It is the general impression that a hundred or more observations by experienced car drivers will indicate the maximum intensity of head-light glare for safe driving.

Roller-Chain Division Meeting

A joint meeting of the A. S. M. E. Roller-Chain Committee and the Roller-Chain Division of the S. A. E. Standards Committee was held Dec. 6 at S. A. E. headquarters, New York. Those present were: C. H. Benjamin, chairman; E. H. Ahara, G. M. Bartlett, W. J. Belcher, W. F. Cole, W. S. Harley, F. B. Hetzel, H. S. Pierce, W. A. Rockenfield, C. E. Whitney and R. S. Burnett of the S. A. E. Standards Office.

Pitches.—The existing series of roller-chain pitches, ½, ⅝, ¾, 1, 1¼, 1½, 1¾, and 2 in., with the addition of a 2½-in. pitch, were favored for recommended practice.

Chain Roller Diameters.—A series of roller diameters were suggested as recommended practice, the selection being made of those approaching most nearly ⅝ of the pitch of the present chain series as follows:

Pitch, in.	½	⅝	¾	1	1¼	1½	1¾	2	2½
Roller dia., in.	0.306	0.400	15/32	⅝	¾	⅞	1	1⅛	1 9/16

Chain Widths.—The width of chains, defined as the distance between the inside links, was recommended as follows:

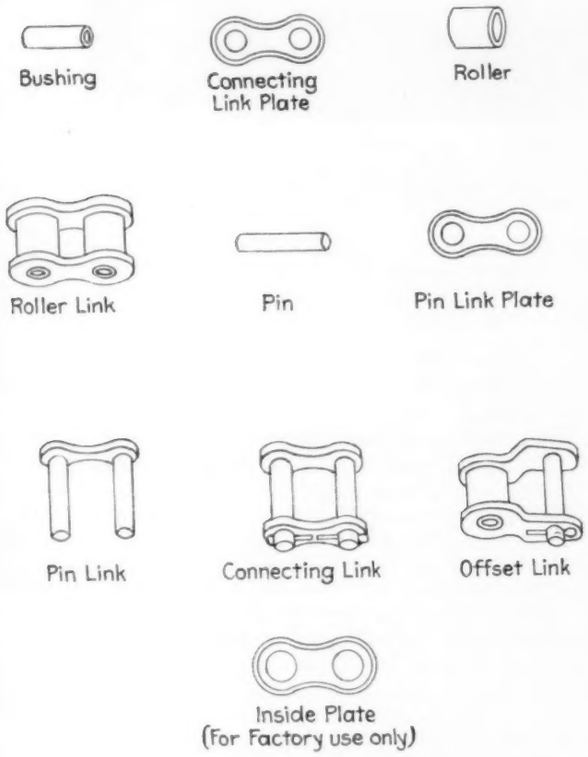
Pitch (in.)	½	⅝	¾	1	1¼	1½	1¾	2	2½
Width (in.)	¼	⅜	½	⅝	¾	1	1	1¼	1½

These recommendations are to be interpreted to mean practices at present influenced by war conditions and are not intended to retard development in any way.

Chain Length Tolerances.—The subject of tolerance per foot of chain length was discussed, no action being taken as no definite information regarding tolerance values was available.

Chain and Sprocket Tolerances.—It was the opinion of the meeting that the serious results from the use of sprockets with oversize "bottom diameters" and chains with undersize "lengths" be emphasized to manufacturers.

Trade Numbers.—It was recommended by the meeting that trade numbers for roller-chains of the recommended pitches be prefixed by the word "Universal." These indicate the number of quarter inches included in the pitch. For instance, chain of ½-in. pitch will be known as "Universal No. 2."



NOMENCLATURE RECOMMENDED FOR ROLLER CHAIN PARTS

Nomenclature.—The practice recommended for standardization for the nomenclature of component parts of roller chains is indicated in the accompanying drawing.

TIRE AND RIM DIVISION MEETING

The meeting of the Tire and Rim Division, held Dec. 10 at Detroit, was attended by the following: E. K. Baker, A. Hargraves, H. R. McMahon, W. S. Wolfe and Standard Manager M. W. Hanks. There was no quorum present so that the action given below is subject to approval later by the Division.

Solid Tire Demountable Rim Equipment for Military Trucks.—The advisability of adapting the former recommendation of the Division on this subject as an S. A. E. standard were discussed. It was said that the demountable solid tire equipment is only temporary and that it has given more or less trouble. The pressed-on rim is thought to be the best, and since this is the case it seems undesirable to standardize the demountable rim. It is possible to put on the demountable equipment by hand, but it is desirable to use the press.

It seemed to be the general opinion that the equipment should not be recommended as an S. A. E. standard for both war and commercial work, but that it might be used as a war measure where the demountable equipment is desired.

In view of these comments, it was recommended that the demountable solid tire equipment shown on War Department drawing T-101 is for war service and for use only where the demountable equipment is desired.

Types and Dimensions of Pneumatic Tire Rims.—It was recommended that the 3-in. and 30 by 3½-in. straight-side rim and all quick-detachable clincher and clincher rims except 3-in. and 30 by 3½-in. clinchers be eliminated as standard practice; that all other sizes be of the straight-side type; also that this notation be added to data sheet 8g, of the S. A. E. Handbook.

Profile, Sizes and Types of Rims.—The Division recommended that Data Sheets 8f and 8g be combined so as to make a more comprehensive sheet with the subjects listed as follows: (a) Drawings and contours; (b) Table of sizes (same as shown on data sheet 8g). (c) Routine tests (same as shown on data sheet 8f). (d) Put in a note calling attention to the elimination as standard practice of the 3-in. and 30 by 3½-in. straight-side rim, and all Q.D.C. and clincher rims except the 3-in., and 30 by 3½-in. clinchers; and that all other sizes to be of the straight-side type.

Pneumatic Tires for Motor Trucks.—It was recommended that the straight-side section be standardized with rim profiles according to the recommendations of the Tire and Rim Association for 6, 7, 8, 10, and 12-in. rims, and that the rim base diameter be 24 in. The tire sizes are to be 36 by 6, 38 by 7, 40 by 8, 42 by 9, 44 by 10, and 48 by 12 in. The 40 and 42-in. wheels use the same rim.

The wood-felloe width is recommended as 3¼ in. for 6-in. rim profiles, 3 29/32 for 6-in.; 4¼ for 8-in.; 5¼ for 10-in., and 7 for 12-in. profiles.

Rims for Cast-Steel Wheels.—It was recommended that a joint meeting be held with the cast-steel wheel makers to determine points worthy of standardization.

Carrying Capacity of Solid Tires.—The members present strongly recommended the table of permissible weights given in former schedule. This provides that the following capacities be used:

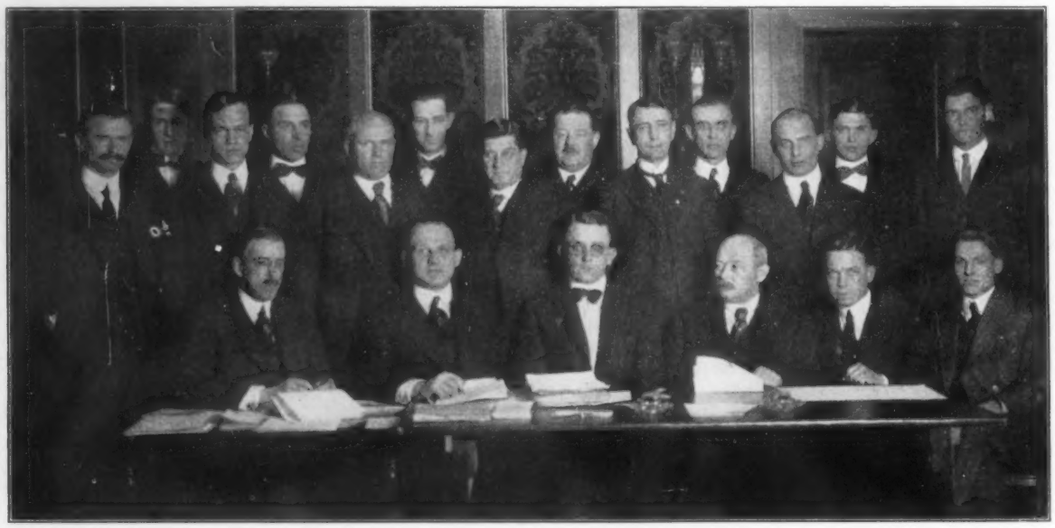
Nominal width of tire....	3	3½	4	5	6	7
Carrying load for 40-in. tires and under	1000	1300	1700	2500	3300	4200

Motorcycle Tires and Rims.—The motorcycle tire and rim drawings dated Oct. 10, 1917, were approved but it was recommended that the valve hole be specified and also that the dimensions of the standard CC rim be checked.

In view of the fact that the rims for the lighter types of motorcycles use the BB section and the heavier type the CC section, it was recommended that these two types be standardized.

TRACTOR DIVISION MEETING

The Tractor Division Meeting held Dec. 5 at Minneapolis was signalized by the attendance of representatives of the American Society of Agricultural Engineers, who will work with the Division in the future in formulating tractor standards. The members of the Division present were: Chairman Dent Parrett, Fred Glover, E. R. Greer, and J. F. Max Patitz (representing the A. S. A.



GROUP IN ATTENDANCE AT MINNEAPOLIS MEETING OF TRACTOR DIVISION

Sitting (left to right), Standards Manager M. W. Hanks, Chairman Dent Parrett, Fred Glover, J. F. Max Patitz, E. R. Greer, H. C. Buffington. Standing, P. M. Heldt, W. T. Burns, R. W. Ballentine, Prof. L. W. Chase, T. B. Funk, Prof. G. A. Young, Jos. Van Blerck, George Cormack, F. F. Chandler, L. H. Keim, C. E. Wilson and F. H. Teagle

E., as did also Prof. L. W. Chase), and Standards Manager M. W. Hanks. The following members of subcommittees and visitors were present: R. W. Ballentine, H. C. Buffington, W. T. Burns, F. F. Chandler, George Cormack, T. B. Funk, P. M. Heldt, A. F. Moyer, R. E. Plimpton, R. B. Shoop, F. H. Teagle, James Van Blerck, C. O. Wiley, J. A. Williams, C. E. Wilson, Prof. G. A. Young, and L. H. Keim.

Punching of Driving Wheels.—The subcommittee on this subject recommended the following for consideration:

1. Holes in all sizes of tractor rims to be punched 11/16 in. for lugs or rivets.

2. Tractor rims to be made 8, 10, 12, 16, 20, 24, or 30 in. wide.

3. Tractor rims to be cut even lengths, 12, 14, 16, 18, 20, 22, or 24 ft.

4. Spokes to be spaced at each 12 in. of rim length, making 12 in. the pitch for lugs and spokes for all wheels.

5. Holes for lugs be spaced halfway between spoke holes, set 2 in. in from each edge of the rim, and that additional holes be punched opposite each spoke, and 4 in. in from the edge of the rim. Additional holes necessary for wider rims.

Specification Forms.—The accompanying condensed specification form was approved by the Division. The complete specification was referred to a committee consisting of Messrs. Parrett, chairman; Funk, Greer, and Patitz for further consideration.

Magneto Impulse Couplings.—The Division recommends that the N. G. E. A. standard distance of 2.375 in. from the large end of the magneto-shaft taper to a point ¾ in. back from the end of the ¾-in. engine shaft be standardized. When the magneto is to be mounted on an iron or steel bracket, a shim at least ½ in. thick made from brass, aluminum or other non-magnetic material should be used and be furnished by the engine builder, so the standard distance from top of shim to center of magneto shaft will be 1.771 in., and also that brass bolts be used to hold down the magneto.

Connecting-Rod Bearings.—After hearing a report on the subject by Jos. Van Blerck, the Division recommends that the subject be tabled pending further developments. It was the consensus of opinion that the industry was not yet ready to consider favorably a standardized series of sizes for connecting-rod bearings.

Condensed Tractor Specification

1. Firm Name .....
   Address .....
2. Tractor Trade Name and Model.....
3. Drawbar Horsepower (S. A. E. Tractor Rating) ....
   Old Trade Rating.....
4. Belt Horsepower (S. A. E. Tractor Rating) .....
   Old Trade Rating.....
5. Engine: Make..... Bore..... Stroke.....
   No. Cylinders.... Cycle..... Normal R.P.M.....
   Lubricating System (Type).....
   Ignition..... Carbureter.....
   Fuel System .....
   Cooling System .....
   Belt Pulley Dia..... Face..... R.P.M.....
6. Transmission Type or Make.....
   No. Speeds Forward.....
   Speed M.P.H. at normal engine speed:
   1st..... 2d..... 3d.....
   Indicate by check (×) speed used for plowing.
7. Wheels: No..... Arrangement.....
   Driving No..... Dia..... Face.....
   Non-driving No..... Dia..... Face.....
   If Track-laying Type, No. of Tracks.....
   Length..... Face.....
8. Frame Construction .....
9. Wheelbase..... Tread.....
10. Width Overall..... Length Overall.....
11. Turning Radius (Half Diameter Largest Track Circle) .....
12. Weight of Tractor (Less Fuel, Oil, Water and Lugs) .....
13. Shipping Weight (Including Standard Equipment and Stays) .....

Power-Belt Widths.—The Division recommends that tractors be equipped with pulleys giving a belt speed of 2600 ft. per min. at the crown of the pulley, that as large pulleys be used as possible, and that the width of the

pulleys vary according to the horsepower delivered, as shown in the following table:

Horsepower	Pulley Width
Under 20	6½
20 to 30 inclusive	7½
31 to 70 inclusive	9½

Screws and Bolts.—It was the consensus of opinion that it would be desirable to eliminate the odd sixteenth-inch sizes above ½ in. The subject will receive further consideration.

Drawbar Design.—Mr. Greer reported that the one-piece clevis submitted at the last meeting of the Division was subjected to test and withstood 20,000 lb. before the ¾-in. clevis bolt gave way; it started to yield at 17,000 lb. With clevis pin the yield started at about 12,000 lb., when the jaws started to spread.

It is recommended that for tractors with 20 drawbar hp., or less, the tractor drawbar be horizontal and ⅝ in. thick, with 13/16-in. holes located with centers 1 in. from edge of bar, that implements be made with drawbars vertical and ⅝ in. thick, with 13/16-in. holes located with centers 1 in. from the edge of the bar; also that additional holes be provided in both tractor and implement drawbars to take care of any adjustment found necessary.

Carbureter Flange.—C. O. Wiley called attention to the seriousness of recommending that carbureters for tractor service be equipped with flanges one size larger than heretofore. If the present S. A. E. flanges were made thicker, so as to obtain a more secure bolting face, there would be no trouble from insecure fastenings or leaky gaskets. A committee was appointed with instructions to immediately arrange for such tests as would definitely determine whether Mr. Wiley's suggestions were practical.

Spark-Plug Shells.—It was voted that the Division rescind its former recommendation to adopt the metric plug as standard and withhold further decision pending action on automobile spark-plug standards.

ORDNANCE SCREW THREAD TOLERANCES

EVER since the early days of the automobile industry, when a standard for fine screw threads was adopted by the Society, the subject of dimensions and tolerances for screw threads has been of prime importance. The data in the accompanying tables should therefore receive the serious consideration of the members of the Society.

The figures represent the tolerances established by the Ordnance Department of the United States Army. They will be used in the manufacture of artillery ammunition, trench-warfare material and for gun parts, when the screw threads are of U. S. standard form.

Since practically all the parts entering into artillery ammunition are expected to function only once, the fits required are not such as would be needed for automobile parts, which are subjected to continuous vibration and wear. In addition a closer fit would tend to decrease production. The Ordnance Department will specify all three fits, in each case allowing the largest tolerance that can be permitted without affecting the functioning of the parts involved.

The experience of American manufacturers in making munitions for the British and Russian Governments has been such that it is believed no difficulty will be had in meeting the requirements of the medium or even of the close fits. It is possible that in some cases they represent a compromise, that they overlap, or that they do not follow a logical plan. But the figures are definite and are believed by the Ordnance Department to represent the best practice that can be put immediately into effect.

Figs. 1, 2 and 3 show just how the Ordnance Department drawings will be prepared. These contain tolerances taken from Table III, which is for medium fits.

Fig. 1, for instance, illustrates the condition of the neutral space found when the female part, or nut, is at its minimum, and the male part, or screw, at its maximum. The maximum screw is the basic size from which all dimensions are computed. All tolerances applied to the diameters on the screw are minus (—), while all those are plus (+) applied to the diameters on the nut.

The way in which screw tolerances should be dimensioned and applied on component drawings is illustrated in Fig. 2. The tolerances indicated in this drawing were chosen from the table (No. III) for medium fits.

Fig. 3 shows the dimensions and tolerances of a nut corresponding to the screw shown in Fig. 2. The minimum nut diameters can be found by adding the amount of the neutral space to the maximum or basic screw diameters.

The class of tolerance applying to any nut and screw depends upon the function of the part. The percentage of strength of full thread required should be duly considered, or in other cases the accuracy required should be taken into account. When these two factors are fully appreciated, then the class of tolerance, such as close fit, medium fit, or loose fit, that best suits the conditions to be met should be used.

TABLE I—DIMENSIONS FOR U. S. STANDARD SCREW THREADS

COARSE THREADS						FINE THREADS					
Threads per Inch	h Single Depth	$2h$ Double Depth	Width of Flat		Pitch	Threads per Inch	h Single Depth	$2h$ Double Depth	Width of Flat		Pitch
4	0.1624	0.3248	0.0312	0.02702	0.2500	20	0.0325	0.0650	0.0062	0.00537	0.0500
5	0.1299	0.2598	0.0250	0.02165	0.2000	22	0.0295	0.0590	0.0057	0.00493	0.0454
6	0.1083	0.2165	0.0208	0.01801	0.1667	24	0.0271	0.0541	0.0052	0.00456	0.0417
7	0.0928	0.1856	0.0179	0.01550	0.1430	28	0.0232	0.0464	0.0045	0.00389	0.0357
8	0.0812	0.1624	0.0156	0.01351	0.1250	30	0.0217	0.0433	0.0042	0.00363	0.0333
9	0.0722	0.1443	0.0139	0.01204	0.1111	32	0.0203	0.0406	0.0039	0.00337	0.0312
10	0.0650	0.1299	0.0125	0.01082	0.1000	36	0.0180	0.0361	0.0035	0.00303	0.0278
11	0.0590	0.1181	0.0114	0.00987	0.0909	40	0.0162	0.0325	0.0031	0.00268	0.0250
12	0.0541	0.1083	0.0104	0.00900	0.0833	44	0.0148	0.0295	0.0028	0.00242	0.0227
13	0.0500	0.0999	0.0096	0.00831	0.0769	48	0.0135	0.0271	0.0026	0.00225	0.0208
14	0.0464	0.0928	0.0089	0.00770	0.0714	56	0.0116	0.0232	0.0022	0.00190	0.0179
16	0.0406	0.0812	0.0078	0.00675	0.0625	64	0.0101	0.0203	0.0020	0.00173	0.0156
18	0.0361	0.0722	0.0069	0.00597	0.0556	72	0.0090	0.0180	0.0017	0.00147	0.0139
						80	0.0081	0.0162	0.0016	0.00138	0.0125

The tolerances specified in the various classes of fits for core diameter of a screw and for the full diameter of a nut differ from those specified for the other diameters. As a result it is possible that a thread can be produced in which the flat at the root is less than that of a true U. S. form thread. This condition is permitted to exist in order that additional wear can be obtained from the cutting tools, thus facilitating manufacture.

The tolerances for the core diameters of screws, and the full diameters of nuts, are so proportioned as to allow

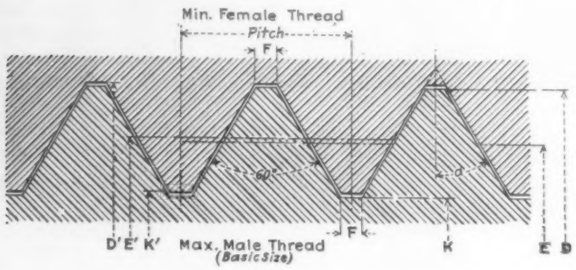


FIG. 1—KEY TO SYMBOLS USED IN TABLES II, III AND IV

taps and threading tools to be made with a flat 75 per cent of the standard class. In no case will these tolerances result in a thread which is cleared more than midway between the true form and a sharp V-form.

TABLE II—SCREW AND NUT TOLERANCES FOR CLOSE FITS

Thds. per Inch	Tolerances on Screws			Neutral Space Between Max. Screw and Min. Nut	Tolerances on Nuts			Minimum per Cent Strength (Approx.)
	D Full Dia.	*E* Effect. Dia.	*K* Core Dia.		*D'* Full Dia.	*E'* Effect. Dia.	*K'* Core Dia.	
4–6	+0.000 −0.008	+0.000 −0.008	+0.000 −0.025	0.008	−0.000 +0.025	−0.000 +0.008	−0.000 +0.008	87
7–10	+0.000 −0.006	+0.000 −0.006	+0.000 −0.016	0.006	−0.000 +0.016	−0.000 +0.006	−0.000 +0.006	84
11–18	+0.000 −0.005	+0.000 −0.005	+0.000 −0.010	0.005	−0.000 +0.010	−0.000 +0.005	−0.000 +0.005	76
20–28	+0.000 −0.004	+0.000 −0.004	+0.000 −0.008	0.004	−0.000 +0.008	−0.000 +0.004	−0.000 +0.004	70
30–40	+0.000 −0.003	+0.000 −0.003	+0.000 −0.006	0.003	−0.000 +0.006	−0.000 +0.003	−0.000 +0.003	68
44–56	+0.000 −0.002	+0.000 −0.002	+0.000 −0.004	0.002	−0.000 +0.004	−0.000 +0.002	−0.000 +0.002	70
64–80	+0.000 −0.0015	+0.000 −0.0015	+0.000 −0.003	0.001	−0.000 +0.003	−0.000 +0.0015	−0.000 +0.0015	70

In order to prevent errors in the construction of gages and other tools, the Ordnance Department requests that a note should appear conspicuously on all parts drawings, as follows:

Threads do not conform at root to U. S. form owing to additional tolerance allowed.

Chairman E. H. Ehrman of the Miscellaneous Division has made the following statement regarding this matter.

The ordnance specification for thread tolerances, while primarily compiled for and specially suited to screw-threads having the relative proportions of diameter and pitch that obtain in ammunition components is a splendid example of a general United States Standard screw-thread specification. It clearly defines the two cardinal elements that insure interchangeability; first the maximum screw size is taken as the nominal or basic size; and, second, the thread shape is such that it does not encroach upon the pure United States Standard thread contour. The value of the first is the fact that the size is fundamental, that it is not affected by allowances or tolerances of any kind; and of the second is that the clearance is obtained by deepening the thread, and does

FIGS. 2 AND 3—ORDNANCE DEPARTMENT DRAWING PRACTICE FOR SCREWS AND NUTS

TABLE III—SCREW AND NUT TOLERANCES FOR MEDIUM FITS

Threads per Inch	Tolerances on Screws			Neutral Space Between Max. Screw and Min. Nut	Tolerances on Nuts			Minimum per Cent Strength (Approx.)
	D Full Dia.	*E* Effect. Dia.	*K* Core Dia.		*D'* Full Dia.	*E'* Effect. Dia.	*K'* Core Dia.	
4–6	+0.000 −0.016	+0.000 −0.016	+0.000 −0.035	0.008	−0.000 +0.035	−0.000 +0.016	−0.000 +0.016	78
7–10	+0.000 −0.012	+0.000 −0.012	+0.000 −0.022	0.006	−0.000 +0.022	−0.000 +0.012	−0.000 +0.012	72
11–18	+0.000 −0.008	+0.000 −0.008	+0.000 −0.014	0.005	−0.000 +0.014	−0.000 +0.008	−0.000 +0.008	65
20–28	+0.000 −0.006	+0.000 −0.006	+0.000 −0.010	0.004	−0.000 +0.010	−0.000 +0.006	−0.000 +0.006	60
30–40	+0.000 −0.004	+0.000 −0.004	+0.000 −0.007	0.003	−0.000 +0.007	−0.000 +0.004	−0.000 +0.004	60
44–56	+0.000 −0.003	+0.000 −0.003	+0.000 −0.005	0.002	−0.000 +0.005	−0.000 +0.003	−0.000 +0.003	59
64–80	+0.000 −0.002	+0.000 −0.002	+0.000 −0.003	0.001	−0.000 +0.003	−0.000 +0.002	−0.000 +0.002	63

not affect the depth of the thread engagement. The recommended depth clearance equals one-half that specified for the international system. The truncated cone shape of clearance is preferable to the rounded optional contour of that system. The establishment of a definite clearance also eliminates one of the most annoying uncertainties in the gaging of screw threads; that is, the possibility that the gage may be bearing at the crest or at the root.

TABLE IV—SCREW AND NUT TOLERANCES FOR LOOSE FITS

Threads per Inch	Tolerances on Screws			Neutral Space Between Max. Screw and Min. Nut	Tolerances on Nuts			Minimum per Cent Strength (Approx.)
	D Full Dia.	*E* Effect. Dia.	*K* Core Dia.		*D'* Full Dia.	*E'* Effect. Dia.	*K'* Core Dia.	
4–6	+0.000 −0.030	+0.000 −0.030	+0.000 −0.045	0.008	−0.000 +0.045	−0.000 +0.030	−0.000 +0.030	61
7–10	+0.000 −0.020	+0.000 −0.020	+0.000 −0.030	0.006	−0.000 +0.030	−0.000 +0.020	−0.000 +0.020	56
11–18	+0.000 −0.012	+0.000 −0.012	+0.000 −0.018	0.005	−0.000 +0.018	−0.000 +0.012	−0.000 +0.012	51
20–28	+0.000 −0.008	+0.000 −0.008	+0.000 −0.012	0.004	−0.000 +0.012	−0.000 +0.008	−0.000 +0.008	48
30–40	+0.000 −0.006	+0.000 −0.006	+0.000 −0.008	0.003	−0.000 +0.008	−0.000 +0.006	−0.000 +0.006	45
44–56	+0.000 −0.004	+0.000 −0.004	+0.000 −0.006	0.002	−0.000 +0.006	−0.000 +0.004	−0.000 +0.004	48
64–80	+0.000 −0.003	+0.000 −0.003	+0.000 −0.004	0.001	−0.000 +0.004	−0.000 +0.003	−0.000 +0.003	47

Activities of S. A. E. Sections

MANY of the sections will not hold meetings in January on account of the Society meetings to be held during that month. The Metropolitan and Mid-West Sections are cooperating with the Meetings Committee of the Society in the preparations for the New York and Chicago meetings respectively. These sections will, in a sense, act as hosts and will form the Reception Committees to welcome the Society members attending the meetings. In addition, the Mid-West Section is making the arrangements for the War Dinner to be held during the Chicago meeting.

The December meeting of the Buffalo Section was held on the 5th, when G. Douglas Wardrop, editor of *The Aerial Age*, discussed the importance of the airplane in war and its commercial possibilities after the war. Mr. Wardrop's talk was well illustrated and brought out almost 600 members of the Buffalo Engineering Society and of the Buffalo Section to the meeting.

The December meeting of the Cleveland Section was held on the 21st, when J. Edward Schipper, of the Class Journal Company, gave an address on What the Automobile User Is Demanding of the Automobile Manufacturer. The January meeting of the Section will probably be held on the 18th, the subject and speakers to be announced later.

At the meeting of the Detroit Section held Nov. 16, a paper on Planning and Mechanical Efficiency, as Applied to the Automotive Industry, was presented by a division of the Industrial Research Committee consisting of George B. McMullen, chairman; C. W. Avery and C. A. Marston. The paper was illustrated by moving pictures showing actual production in the Ford and Packard factories. A complete outline was given of a working organization of modern automobile factories, of the production methods followed in the best practice, and of the floor layout required for the most efficient production.

The December meeting of the section will be held on the 21st and will take the form of a "get-together" smoker, at which problems of interest to the Nation and to the Section will be discussed. C. E. Fraser Clark, recently returned from France, will tell of his experiences while serving with the old American Ambulance Field Service.

A well-attended meeting of the Indiana Section was held Dec. 7 when a paper was presented by G. W. Gurney entitled Some Fundamentals of Rolling Support. The meeting was held jointly with the Engineers Club of Indianapolis. Mr. Gurney took up some of the elementary theories of rolling support of revolving parts as distinguished from sliding supports. He described the requirements of the ideal bearing and then reviewed the advantages of different types of frictionless bearing construction. On account of the shows no January meeting of the Section will be held.

The following officers of the Indiana Section were elected to fill vacancies: Earl Beeson, chairman; Edward Reeser, treasurer, and R. H. Sheeders, secretary.

Metropolitan Section Activities

The Metropolitan Section has planned a comprehensive program, dealing with topics which are of the most general interest to the members of the Section and to the Society at large.

New York is far from being the designing center of the automobile industry, but it is preeminently the headquarters of the principal commercial, merchandising and financial interests. It is the desire of the Section to reach as large a number of men connected with the automotive industry as possible, including not only the designing and production engineers, but the dealers, jobbers, users, financiers, and those contributing indirectly as well as directly to the industry.

The first paper of the year was devoted to recent developments in aviation and to the part which this service plays in the present war.

The November meeting was devoted to an important phase of the fuel problem. The suggestion that superheated dry gas replace the wet mixtures usually in automotive engines carried a message of the greatest importance to the manufacturer and the dealer alike, one almost revolutionary in its aspects.

This meeting was attended by several representatives of the oil industry, and it is the belief of the Section that it has marked the beginning of closer cooperation between the fuel-refining interests and the automobile manufacturers.

The December meeting will be held on the 27th and will be devoted to the study of the Relation of the War to the Passenger Car, in its effects upon the manufacturer, the buyer, the dealer, and the Government. The paper will be given by A. L. Clayden, who is undoubtedly one of the best-posted authorities on this subject in the country. The subject is one of supreme significance at this time in view of the apprehensions regarding the curtailment of the passenger-car industry.

No meeting of the Section will be held in January. The next regular meeting will be held in February, when it is planned to discuss the merchandising side of the industry with reference to the part the dealer and the jobber bear upon the industry at large, and in particular his status during the war period.

At a later meeting the financial side of the automotive industry will be discussed in its past and present aspects, contributions being made by some of the leading New York bankers who have been identified with the automobile industry.

It is intended to treat the tractor situation later in the winter, in order to bring to the East some appreciation of the increasingly important part which this industry is to play in our national life at large, as well as in the farm districts of the West.

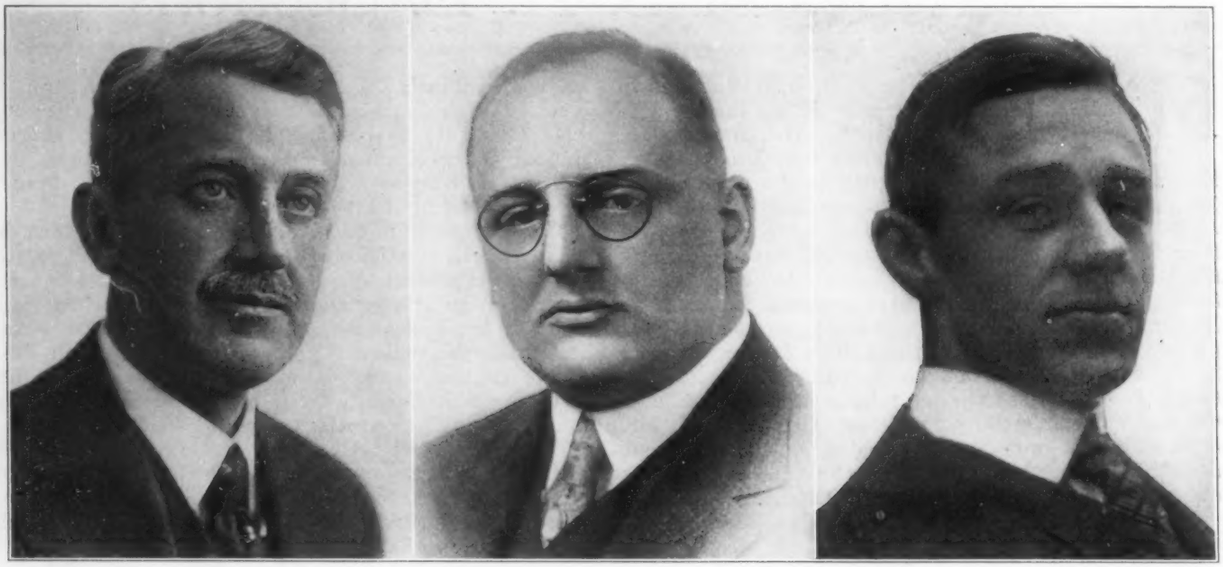
The final meeting of the season will be devoted to the latest developments in the war automotive field.

The Metropolitan Section welcomes to its meetings any one interested in the automotive fields. It is endeavoring to enlist the cooperation and interest of nonmembers as well as members in the closer binding together of the elements that go to make up one of the largest manufacturing industries in the country.

The officers of the Metropolitan Section are: H. G. McComb, chairman; Leonard Kebler, vice-chairman; H. W. Slauson, secretary; A. C. Bergman, treasurer; C. F. Scott, chairman of meetings and papers committee, and Reuben Allerton, chairman of membership committee.

Mid-West Section Meetings

At the Mid-West Section meeting held Nov. 23, three technical papers were presented. F. A. Craven described a type of farm tractor that has been in service for a number of years and was presented as an example of enduring and conservative design. H. D. Kramm described some experimental work that he has been doing



OFFICERS OF METROPOLITAN SECTION. LEFT TO RIGHT—REUBEN ALLERTON, CHAIRMAN MEMBERSHIP COMMITTEE; A. C. BERGMANN, TREASURER; C. F. SCOTT, CHAIRMAN PAPERS COMMITTEE

in using renewed aluminum metal and in obtaining malleable aluminum castings. G. W. Gurney called attention to the need for quick production of tractors to take care of the impending shortage of labor and food. He said:

"The last branch of human endeavor to become modernized by the multiplying magic of applied power is the most basic of all—agriculture. The hoe and sickle are wielded today as they were in Mesopotamia a hundred centuries ago. The great task of producing the food of the race is still to a considerable extent performed in the same primitive ways that were in vogue when Cheops built his pyramids. At this late day we are discussing pro and con improvements on the agricultural methods of Sargon the gardener king of Akkad (3000 B.C.).

"We are today appraising the relative values, as applied to the tillage of the fields, of the modern internal-combustion engine and the power plant of the ancient Chaldean—the horse and the ox. Shall we plow with a power plant that eats a considerable part of the produce from the limited furrows it turns, or shall we do as we have long since done in every other industry—use twentieth-century methods? A tractor doing the work of nine to twenty horses releases 18 to 40 acres for available productivity; it also releases men workers to other and more direct activities, for a slip of a girl can run the tractor.

"Under the peculiar conditions of the present day the usefulness of the tractor is simply that of a great labor-saving device available in agriculture at the critical moment when the world faces its greatest and most acute shortage of labor. The tractor is, accordingly, one of the most useful things that Yankee ingenuity has produced; and it is, accordingly, the patriotic duty of the American tractor builders to build tractors and see that they are gotten into the fields with the greatest possible speed."

The December meeting of the Mid-West Section was held on the 14th of the month, three papers being presented. Lieut. W. G. Hamilton, of the Canadian Black Watch, who has seen considerable service at the front, spoke on truck and transportation work in France. George W. Smith described the work done by United States Army trucks on the Mexican Border last year. W. B. Stout, technical advisor of the International Standards Aircraft Board, spoke on the industrial development of airplanes.

Minneapolis Section Activities

The Minneapolis Section met on the 5th, immediately following the all-day meeting of the Tractor Division of the Standards Committee. At the technical session a paper on Tractor Starting, Lighting, and Ignition, prepared by Burns Dick, was read by J. A. Gelzer. A paper discussing the relative merits of magneto and battery ignition was presented by J. A. Williams. A general discussion followed as to the possibility of using electrical equipment on tractors. The tractor engineers present mostly seemed to feel that there is no place on the tractor for electric lighting and starting equipment, that the batteries would have extremely short life on account of the vibration and severe service, and that the complexity introduced by the electrical wire would be objectionable to the farmers operating the tractors.

On the other hand, it was said that the use of starting equipment should permit tractors to be operated by non-robust labor, such as boys, old men and women, thus compensating for the labor shortage. In addition the starter would actually decrease fuel consumption as well as drudgery connected with the operation. Electric lighting would permit the tractor to be used a large number of hours per day; the farmer now stops at sundown, more as a matter of habit than anything else, and because his horses cannot work at night. One speaker presented the interesting point that if the tractor could be used longer hours the total power equipment necessary to carry on farm work efficiently could be decreased 50 per cent.

At the November Pennsylvania Section meeting, W. S. Wolfe presented a paper on Size, Inflation, Pressure and Construction of Tires as Affecting Easy Riding. Mr. Wolfe reviewed the effects on riding qualities of solid

OFFICERS OF METROPOLITAN SECTION. LEFT TO RIGHT—H. W. SLAUSON, SECRETARY; LEONARD KEBLER, VICE-CHAIRMAN; H. G. MCCOMB, CHAIRMAN

and pneumatic tires, stating that the latter gave the best results when of the straight-side cord construction. He also gave information regarding experimental work now being conducted in using pneumatic tires on large trucks. Mr. Wolfe's paper will appear in an early issue. The next meeting of the Section will probably be held Jan. 24 and will be devoted to the discussion of upholstery as affecting the riding qualities of vehicles.

REPORT OF DECEMBER COUNCIL MEETING

The December meeting of the Council was held on the 10th at the Washington office of the Society, those present being President George W. Dunham, Councilors David Beecroft, H. L. Horning, C. W. McKinley, Treasurer Herbert Chase and General Manager Coker F. Clarkson.

Councilor Beecroft submitted a report as charman of the Meetings Committee in which he said that it had finally been decided to hold the Chicago dinner at the New Morrison Hotel. The sale of tickets for the Automotive Industries Dinner at the New York Show and for the War Dinner at the Chicago Show is progressing, and arrangements have been made for a number of high-class technical papers to be given at the professional sessions.

Applicants to the number of 127 were elected to membership in the Society, these being assigned to grades as follows: 43 Members, 42 Associate Members, 14 Junior Members, 4 Affiliate Members, 9 Affiliate Member Representatives, and 15 Student Enrollments.

Councilor McKinley presented a report as chairman of the Membership Committee in which he stated that the Committee was planning to institute an organized effort for the purpose of interesting the large number of engineers and executives in the automotive industries who should belong to the Society.

It was voted to make the following transfers in grade of membership: From Associate to Member, Alfred L. Campbell, Lloyd B. Duntley, Arthur P. Emmert, Meredith Matthews, Edward L. Parris, Jr., Herbert D. Shamberg, Charles G. Spice, J. A. Tarkington, Perry L. Tenney, and Leo J. Werner. From Junior to Member: Julius M. Breitenbach, Austin M. Wolf, and William S. Wolfe. From Associate to Junior, O. F. Schmidt.

A report was presented for the Sections Committee to the effect that an amendment should be made to the constitution of the Society so that the Sections Committee should become one of the administrative committees regularly appointed by the President. This suggestion was referred to the Committee on Constitutional Amendments for consideration.

Samples of new Society emblems were exhibited, and it was decided to place in stock for the benefit of the members a much smaller button than the pin now available and to use an intermediate size when the present stock of large pins is exhausted.

The resignation of Fred Glover as a member of the Standards Committee with assignment to the Tractor Division was accepted with regret.

It was decided to appoint two members to represent the Society at the International Aircraft Standardization Conference, which will be held late in January in London.

A committee consisting of Dent Parrett, C. M. Eason, and F. E. Place was appointed to represent the Society at the annual meeting of the American Society of Agricultural Engineers, which will be held late in December in Chicago.

It was decided to appoint a Field Secretary of the Society to follow Section and other Society activities that require direct personal contact with the members. R. E. Plimpton, formerly Publication Manager of the Society, was designated Field Secretary, to take up the work actively just as soon as possible.

It was decided to call the next meeting of the Council Jan. 9 at the New York office of the Society. This is the day preceding the Annual Meeting.

Service Directory of Members

THE following list is intended to contain the names of all members connected with the Government either in the military services or in civilian capacities. The names are listed in two parts, the first showing the members who have actually entered the military services, and the second those engaged as civilians. Every effort is made to have the addresses correct, but many of the members are changing about so much that it is almost impossible to tell accurately as to just where they are located at any given time. It is therefore requested, in case of any error, that the member concerned immediately inform the New York Office of the Society, so that a proper correction can be made. Members who have actually entered the service in any capacity, and who are not listed, should also write the details to the New York Office.

Military Honor Roll

Alden, Herbert W., major, Motor Equipment Section, Carriage Division, Ordnance O. R. C., A. E. F., France.

Ames, Butler, brigadier general, Mass. State Militia, Lowell, Mass.

Anderson, William C., lieutenant, Engineer O. R. C., Brooklyn, N. Y.

Arnold, Bion J., major, Engineer O. R. C., Washington.

Barker, C. Norman, pilot cadet, Royal Flying Corps, Camp Borden, Can.

Barton, W. E., first lieutenant, Quartermaster O. R. C., Washington.

Bibb, John T., Jr., private, Aviation Section, Signal Corps, A. E. F., France; (mail) 3rd Foreign Detachment, Cadet Flying Squadron, A. E. F., France.

Blank, M. H., first lieutenant, Ordnance O. R. C., Washington.

Blood, Howard E., lieutenant, Engine Design Section, Equipment Division, Signal Corps, U. S. A., Washington.

Britten, Wm. B., captain, assistant to Officer in Charge of Transportation, Quartermaster O. R. C., Washington.

Browne, Arthur B., captain, Sanitary Corps, U.S.N.A., (mail) General Motors Co., Detroit.

Brown, Harold Haskell, first lieutenant, New York Artillery, Centerport, L. I.

Callan, John Lansing, lieutenant, Reserve Flying Corps, U. S. N., U. S. S. Seattle, (mail) Postmaster, New York.

Clark, Edward L., first lieutenant, Signal O. R. C., McCook Field, Dayton, Ohio.

Clark, Virginius E., lieutenant colonel, Signal Corps, U. S. A., McCook Field, Dayton, Ohio.

Coe, Edw. M., first lieutenant, Quartermaster Corps, U. S. A., Washington.

Deeds, Edward A., colonel, Equipment Division, Signal Corps, U. S. A., Washington.

De Lorenzi, Ernest A., officer, Mechanical Transport, War Department, London, Eng.

De Witt, George W., lieutenant, U. S. Naval Militia, Jacksonville, Fla.

Dickey, Herbert L., captain, Motor Equipment Section, Carriage Division, Ordnance O. R. C., Washington.

Earle, Lawrence H., first lieutenant, Ordnance O. R. C., assigned as inspector of ordnance, Holt Mfg. Co., Peoria, Ill.

Eells, Paul W., lieutenant, 330th Field Artillery, O. R. C., Camp Custer, Battle Creek, Mich.

Farrell, Matthew, captain, Quar. U. S. R., Washington.

Fishleigh, W. T., major, Sanitary Corps, U. S. N. A., Washington, assigned as automobile engineer.

Flanigan, E. B., Officers' Reserve Training Camp, Plattsburg, N. Y.

Forrer, J. D., captain, Engineer O. R. C., Washington.

Foss, Clarence M., captain, Ordnance O. R. C., Rock Island Arsenal, Rock Island, Ill. Assigned to Motor Section.

Fox, Rudolph H., first lieutenant, Ordnance O. R. C., Washington.

Furlow, James W., lieutenant colonel, Quartermaster Corps, U. S. A., Washington, assigned to Office of Quartermaster General.

Gaebelein, Arno W., lieutenant, Ordnance O. R. C., Washington, assigned to Carriage Division.

Gardner, Lester D., captain, 117th Aero Squadron, Signal Corps, U. S. A., Washington.

Gforer, A. H., first lieutenant, Ordnance O. R. C., Washington.

Gillis, Harry A., major, Ordnance O. R. C., Washington.

Gorrell, Edgar S., lieutenant colonel, Aviation Section, Signal Corps, U. S. A., Washington.

Gray, B. D., major, Equipment Division, Aviation Section, Signal O. R. C., Washington.

Green, Geo. A., captain, Tank Section, B. E. F., France.

Guthrie, James, major, Ordnance O. R. C., Washington, assigned to Field Artillery Section, Carriage Division.

Hall, Elbert J., major, Engine Design Section, Engineering Division, Signal Corps, U. S. A., Washington.

Harms, Henry W., captain, Av. Sec., Signal Corps, U. S. A., Washington.

Hartman, A. A., private, U. S. N. A., Camp Devons, Ayer, Mass.

Hegeman, Harry A., major, Quartermaster Corps, U. S. A., Washington, assigned to Office of Officer in Charge of Transportation.

Horner, Leonard S., major, Equipment Division, Signal Corps, U. S. A., Washington.

Hubbell, Lindley D., major, Ordnance O. R. C., Springfield, Mass., assigned as Officer in Charge, Hill Shops, Springfield, Armory.

Jennings, J. J., first lieutenant, Quar. U. S. R., A. E. F., France.

Joy, Henry B., captain, Aviation Section, Signal O. R. C., Washington.

Kline, Harmon J., Officers' Reserve Training Camp, Fortress Monroe, Va.

Lanza, Manfred, major, Quartermaster Corps, U. S. A., headquarters 78th Division, Camp Dix, N. J.

Larsen, Lester Reginald, second lieutenant, Engineer O. R. C., Washington.

Lavery, Geo. L., Jr., first lieutenant, Ordnance O. R. C., Washington.

Lay, Arthur J. captain, Aviation Section, Signal O. R. C., Washington.

LeFevre, Wm. G., lieutenant, Ordnance O. R. C., Washington.

Lewis, Charles B., captain, Ordnance O. R. C., Camp Lewis, American Lake, Wash.

Lewis, Harry R., Jr., first lieutenant, Ordnance O. R. C., Springfield Armory, Springfield, Mass.

Lipsner, B. B., captain, Air Division, Aviation Section, Signal O. R. C., Washington.

McIntyre, H. C., captain, Ordnance O. R. C., Washington.

Mackie, Mitchell, adjutant, Quartermaster Corps, U. S. A., A. E. F., France, assigned to Motor Truck Transport Section.

Marmon, Howard, captain, Airplane Engineering Department, Aviation Section, Signal O. R. C., McCook Field, Dayton, Ohio.

Marshal, W. C., captain, Ordnance O. R. C., Washington.

Martin, Kingsley G., captain, Quartermaster O. R. C., Washington, assigned to Southern Department.

May, O. J., captain, Aviation Section, Signal O. R. C., Camp Custer, Battle Creek, Mich.

Middleton, Ray T., first lieutenant, air service, A. E. F., Paris, France.

Moffat, Alex. W., ensign, commanding U. S. S. "Tamarack" (S. P. 561), Naval Defense Reserve, Postmaster, Foreign Station, New York.

Morgan, M. B., captain, Ordnance O. R. C., Washington.

Myers, J. L., first lieutenant, Ordnance O. R. C., Washington.

Nahikian, S. M., 4th Battery, Second O. T. R., Ft. Sheridan, Ill.

Ommundson, H. P., Flying Corps, U. S. N., Aeronautic Station, Pensacola, Fla.

Pagé, Victor W., first lieutenant, Aviation Section, Signal O. R. C., Mineola, N. Y.

Paine, C. L., captain, Ordnance O. R. C., 318 North Illinois Avenue, Indianapolis, assigned to work on tanks.

Parker, Richard E., captain, Quartermaster O. R. C., Washington, assigned to Southern Department.

Pearmain, W. J., captain, Ordnance O. R. C., A. E. F., France.

Peifer, Carl B., lieutenant, Specification Section, Signal Corps, U. S. A., Washington.

Pfeiffer, Ben. S., first lieutenant, Ordnance O. R. C., Rock Island Arsenal, Rock Island, Ill., assigned to Motor Section.

Potter, Austin E., lieutenant, New York Naval Militia, Brooklyn, N. Y.

Powell, W. B., officer in charge of transportation, Imperial Ministry of Munitions, (mail) Box 94, Quebec, Can.

Pullen, Daniel D., captain, 7th Regiment, Engineer Corps, U. S. A., Fort Leavenworth, Kan.

Ranney, A. Elliot, major, Air Division, Signal Corps, U. S. A., Washington.

Rose, Charles B., captain, Equipment Division, Signal Corps, U. S. A., Washington.

Rosenthal, Wm. C., private, U. S. N. A., 507 Nineteen Hundred Euclid Bldg., Cleveland.

Schoenfuss, F. H., captain, Ordnance O. R. C., Washington.

Schoepf, T. N., captain, Engineer O. R. C., Washington.

Selfridge, S. W., first lieutenant, Ordnance O. R. C., Washington.

Slade, Arthur J., captain, Aviation Section, Signal O. R. C., Washington.

Smith, Mark A., first lieutenant, Marine Corps, U. S. N., Washington.

Sprague, G. A., Co. D., 310th Engineers, Camp Custer, Battle Creek, Mich.

Strahlman, Otto E., first lieutenant, Aviation Section, Signal O. R. C., (mail) McCook Field, Dayton, Ohio.

Swinton, D. R., first lieutenant, Quartermaster Corps, U. S. A., assigned to Office of Quartermaster General.

Thompson, H. E., first lieutenant, Motor Equipment Section, Carriage Division, Ordnance O. R. C., Washington.

Thomson, Clarke, lieutenant, Signal O. R. C., Washington.

Tolman, Edgar Bronson, Jr., first lieutenant, 311th Engineers, U. S. A., Camp Grant, Rockford, Ill.

Turner, Harry C., captain, Eng. U. S. R., A. E. F., France.

Twachtman, Quentin, first lieutenant, Engine Design Section, Signal O. R. C., Washington.

Vail, E. L., lieutenant, Signal Corps, U. S. A., Washington.

Vincent, Jesse G., major, Aviation Section, Signal Corps, U. S. A., Miami Hotel, Dayton, Ohio.

Waldon, Sidney D., colonel, Equipment Division, Signal Corps, U. S. A., Washington.

Wall, William Guy, major, Ordnance O. R. C., Washington, asigned to motorization work.

Walter, Maurice, first lieutenant, Ordnance O. R. C., Washington.

Walton, Frank, acting sergeant, Quartermaster Corps, U. S. A., assigned to Quartermaster Repair Unit, Camp Meigs.

Wetherill, S. P., Jr., major, Quartermaster O. R. C., Washington.

Whittenberger, Owen M., first lieutenant, Ordnance O. R. C., Washington, assigned to Office of Chief of Ordnance.

Wilson, T. S., major, First Indiana Field Artillery, Lafayette, Ind.

Wood, Harold F., lieutenant, Specification Section, Equipment Division, Signal O. R. C., Washington.

Recent Additions

Bowen, C. H., captain, Military Truck Production Section, office of Quartermaster General, Washington.

Campbell, Lindsey F., 4th Battery, 2d P. T. R., Fort Sheridan, Ill.

Dayton, William E., private, 306th Regiment, Field Artillery, U. S. N. A., Washington.

Dickey, H. L., captain, Motor Section, Ordnance Dept., U. S. A., Washington.

Donaldson, Frank A., captain, Quartermaster U. S. R., U. S. A., Minneapolis.

Dost, Charles O., first lieutenant, Aviation Section, Signal Corps, U. S. A., Cornell University, Ithaca, N. Y.

Finkenstaedt, Edward R., first lieutenant, Military Truck Production Section, office of Quartermaster General, Washington.

Howard, Walter S., first lieutenant, Military Truck Production Section, office of Quartermaster General, Washington.

Jeffrey, Max L., first lieutenant, Military Truck Production Section, office of Quartermaster General, Washington.

Kendrick, John F., Signal Corps, A. E. F. France, assigned to Research Inspection Division.

Kohr, Robert F., second lieutenant, Engineers O. R. C., Washington.

McMurtry, Alden L., captain, office of Surgeon General, Sanitary Corps, U. S. N. A., Washington.

May, Henry, Jr., first lieutenant, Military Truck Production Section, office of Quartermaster General, Washington.

Rawley, Jos., captain, Co. A, 310th Engineers, U. S. A., Camp Custer, Battle Creek, Mich.

Titsch, Walter H., captain, Quartermaster Corps, U. S. N. A., Washington.

Vonachen, F. J., lieutenant, Ordnance Department, U. S. N. A., Rock Island Arsenal, Rock Island, Ill.

Woods, Samuel H., first lieutenant, Military Truck Production Section, office of Quartermaster General, Washington.

Civilian Honor Roll

Adams, Porter H., Office of the Section Commander. First Naval District, Rockford, Me.

Anderson, E. S., mechanical engineer, Aviation Section, Signal Corps, U. S. A., Rockwell Field, N. Island, San Diego, Cal.

Bare, Erwin L., automobile body designer, Office of Quartermaster General, Washington.

Barnhardt, Geo. E., instructor, Signal Corps Aviation School, San Diego, Cal.

Bourquin, J. F., supervisor of chassis assembly, Military Truck Production Section, Office of Quartermaster General, Washington.

Caldwell, Frank W., aeronautical mechanical engineer, Aviation Section, Signal Corps, Washington, (mail) 1449 Massachusetts Avenue, N. W.

Chapman, Robert H., U. S. N., Spartanburg, S. C., assigned to Aeronautical Division.

Chauveau, Roger, aeronautical mechanical engineer, Aviation Section, Signal Corps, Washington.

Coffin, Howard E., chairman, Aircraft Production Board, Washington.

Costello, John V., aeronautical engineer, airplane engineering division, Signal Corps, Dayton, Ohio.

DeKlyn, John H., technical assistant, National Advisory Committee on Aeronautics, Washington.

Diffin, F. G., chairman, International Aircraft Standards Board, Washington.

Edgerton, A. H., aeronautical mechanical engineer, Inspection Section, Signal Corps, U. S. A., assigned to Equipment Division.

Elliott, E. M., U. S. Public Service Reserve, Department of Labor, 1712 I Street, Washington.

Ericson, Friehof G., representative of Canada, International Aircraft Standards Board, Washington.

Fowler, Harlan D., aeronautical engineer, Aviation Section, Signal Corps, Mineola, N. Y.

Gill, R. O., inspector of airplanes, Equipment Division, Signal Corps, (mail), Dayton-Wright Airplane Co., Dayton, Ohio.

Girl, Christian, director, Military Truck Production Section, Office of Quartermaster General, Washington.

Gorman, E. J. B., U. S. Naval Reserve Flying Corps, Dayton, Ohio, assigned to inspection of airplane engines, Dayton-Wright Aeroplane Co.

Gunn, E. G., production engineer, Quartermaster Corps, U. S. A., Washington, assigned to Motor Transportation Division.

Hallett, Geo. E. A., aeronautical mechanical engineer, Signal Corps, Aviation School, San Diego, Cal.

Hobbs, J. W., automobile expert, Ordnance Department, Rock Island Arsenal, Rock Island, Ill.

Horine, M. C., inspector, airplane engineering division, Signal Corps, Washington.

Holden, F. M., airplane engineering division, Signal Corps, U. S. A., Washington.

Hoyt, F. R., Aviation Section, Signal Corps, Washington.

King, Charles B., aeronautical mechanical engineer, Aviation Section, Signal Corps, Washington.

Kishline, Floyd F., laboratory assistant, Quartermaster Corps, Washington.

Lane, Abbott A., inspector, Aviation Section, Signal Corps (mail), Room 52, 870 Woodward Avenue, Detroit.

McCain, Geo. L., Signal Corps, U. S. A., Dayton, Ohio, assigned to airplane engineering department, Engine Design Section.

McMaster, Marcenus D., aeronautical engineer, Equipment Division, Signal Corps, Washington.

Mennen, F. E., Quartermaster Corps, U. S. A., Washington, assigned to Transportation Division.

Morgan, G. W., supervisor of plant survey, Military Truck Production Section, Office of Quartermaster General, Washington.

Neumann, John W., Planning Section, Machine Division, U. S. Navy Yard, Philadelphia.

Norris, G. L., Inspection Section, Equipment Division, Signal Corps, Washington.

O'Malley, John M., instructor in motor engineering, Aviation School, Signal Corps, Washington.

Otis, J. Hawley, Ordnance Department, U. S. A., Camp Dodge, Des Moines, Iowa.

Parish, W. F., Signal Corps, U. S. A., Washington, assigned to Specification Section, Equipment Division.

Parker, Victor C., Signal Corps, U. S. A., Washington, assigned to Equipment Division.

Parris, Jr., Edward L., senior inspector, Aviation Section, Signal Corps, (mail) Ericsson Mfg. Co., Buffalo.

Perrin, J. G., assistant, Signal Corps, U. S. A., 401 Lindsey Bldg., Dayton, Ohio, assigned to airplane engineering division.

Proctor, C. D., Ordnance Department, U. S. A., Rock Island Arsenal, Rock Island, Ill. Assigned to Motor Section, Carriage Division.

Rice, Harvey M., inspector, Aviation Section, Signal Corps, (mail) Curtiss Aeroplane Co., Buffalo.

Rippingille, E. V., Aviation Section, Signal Corps, Washington.

Rogers, John M., aeronautical engineer, Bureau of Construction & Repair, Navy Department, Washington.

Salisbury, Edward V., chief of motor transportation, American International Corp., Government Shipbuilding Yard, Hog Island, Philadelphia.

Schupp, Arthur A., aeronautical mechanical engineer, Aviation Section, Signal Corps, Washington.

Serrell, Ernest, aeronautical mechanical engineer, Aviation Section, Signal Corps, Washington.

Sloane, Jno. E., Signal Corps, U. S. A., Washington, assigned to Equipment Division.

Smith, G. W., Jr., aeronautical mechanical engineer in charge of experimental division, Engineering Department, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia.

Stanton, D. T., military instructor, U. S. Army School of Military Aeronautics, Cornell University, Ithaca, N. Y.

Stout, William B., technical advisor, International Aircraft Standards Board, Washington.

Tone, Fred I., inspector, Aviation Section, Signal Corps, Washington.

Tracy, Percy Wheeler, supervisor of parts plants, Military Truck Production Section, Office of Quartermaster General, Washington.

Utz, John G., supervisor of inspection, Office of Military Truck Production Section, Office of Quartermaster General, Washington.

Van Loon, Henry M., 310th Engineers, Camp Custer, Battle Creek, Mich.

Wade, Gustav, inspector, Aviation Section, Signal Corps, Washington.

Waldron, Russell E., Signal Corps, U. S. A., Detroit, assigned to Equipment Division.

Walter, John M., mechanical draftsman, Bureau of Ordnance, Navy Department, Washington.

Waterhouse, W. J. aeronautical engineer, Aviation Section, Signal Corps, (mail) Dayton-Wright Airplane Co., Dayton, Ohio.

Whinne, Wilbur H., inspector, Quartermaster Corps, U. S. A., Detroit.

Recent Additions

Burton, W. Dean, aeronautical mechanical engineer, Signal Service, U. S. A., Fort Omaha, Neb.

Clark, Elmer J., Signal Corps, U. S. A., Portland, Ore., assigned as district manager of inspection.

Froesch, Charles, aeronautical mechanical engineer, Aviation Section, Signal Corps, Washington.

Hale, W. A., aeronautical mechanical engineer, Signal Corps, U. S. A., Dayton, Ohio.

Heckel, C. E., truck designer, Transport Division, Quartermaster Corps, U. S. A., Washington.

Hicks, Harlie H., airplane engineering division, Signal Corps, U. S. A., Dayton, Ohio.

Honigman, Jos. K., instructor, U. S. School of Military Aeronautics, Princeton University, Princeton, N. J.

Kalb, Lewis P., assistant supervisor of inspection, Military Truck Production Section, office of Quartermaster General, Washington.

Laddon, I. M., aeronautical mechanical engineer, Signal Corps, U. S. A., McCook Field, Dayton, Ohio.

Nelson, A. L., aeronautical mechanical engineer, Signal Corps, U. S. A., McCook Field, Dayton, Ohio.

Schell, John A., aeronautical mechanical engineer, Signal Corps, U. S. A., McCook Field, Dayton, Ohio.

Stalb, Arthur R., Jr., U. S. Navy Aeronautic Station, Pensacola, Fla., assigned as aeronautic draftsman, Hull Division.

Thibault, F. J., aeronautical mechanical engineer, Signal Corps, U. S. A., Washington.

Walker, Karl F., automotive engineer, Quartermaster Corps, U. S. A., Washington, assigned to Engineering Laboratory.

Weiss, E. A., automobile designer, Quartermaster Corps, U. S. A., Washington (mail), 812 C Street, S. E.

White, Percival, automobile expert, Ordnance Department, U. S. A., Rock Island Arsenal, Rock Island, Ill.

Worthen, C. B., inspector, Aviation Section, Signal Corps, U. S. A., Washington.

PERSONAL NOTES OF THE MEMBERS

Reuben Allerton, heretofore identified with the ball bearing and automobile parts industry, and at one time vice-president of the Columbia Lubricants Company, is now president of the Allerton Engineering Corporation, 50 Church Street, New York, specializing in anti-friction bearings, die castings, fire prevention, accident prevention and lubrication.

Gould, Allen, formerly sales and advertising manager, Covert Motor Vehicle Co., Lockport, N. Y., is sales manager, Fuller & Sons Mfg. Co., Detroit.

Joseph Berg, formerly chief engineer, Stewart-Warner Speedometer Corp., Chicago, is with the Champion Ignition Co., Flint, Mich.

Ralph B. Burton, formerly chief draftsman experimental department, Republic Motor Truck Co., Inc., Alma, Mich., is experimental designer, Dayton Engineering Laboratories Co., Dayton, Ohio.

George F. Bean, formerly general superintendent, Scripps-Booth Corp., is manager and vice-president, Bemet Mfg. Co.

O. R. Baker, formerly sales manager, Doehler Die Casting Co., Brooklyn, N. Y., at Toledo Ohio, is now at 914 Ford Building, Detroit.

S. R. Bennett, formerly assistant supervisor, Bosch Magneto Co., Springfield, Mass., is now supervisor of the testing departments.

William A. Carrell, formerly superintendent, motor plant, International Harvester Co., is engineer and works manager, Erd Motor Co., Saginaw, Mich.

Hugh R. Corse, formerly sales manager, bronze department, The Titanium Alloy Mfg. Co., Niagara Falls, N. Y., now holds the same position with the Titanium Bronze Co., Inc., Niagara Falls, N. Y.

Roland Chilton, formerly engineer at 1790 Broadway, New York, is with the Aeromarine Plane & Motor Co., Keyport, N. J.

N. J. Clausen, formerly draftsman, Otis Elevator Co., New York, is with the Curtiss Engineering Corp., Garden City, N. Y.

George M. Cohn, formerly draftsman, Clayden Motor Car Syndicate, New York, is layout man in engineering department, Chevrolet Motor Co., New York.

Charles de Lukacsevics, formerly owner and manager, C. de L. Engineering Works, West Nutley, N. J., is located in New York.

Walter E. Dugan, formerly general superintendent, Selden Motor Vehicle Co., Rochester, N. Y., is factory manager, United States Motor Truck Co., Cincinnati.

Melvin F. Doty, formerly salesman, Isaac G. Johnson & Co., Spuyten Duyvil, N. Y., is manager of production department, Michigan Steel Casting Co., Detroit.

George H. Duck, formerly agency and purchasing agent, John MacGregor Grant, Inc., New York, is now manager, *Commercial Car Journal*, Cleveland.

Albert E. Eldredge has severed his connection as manager marine engine department, Mason Machine Works, Taunton, Mass.

C. P. Grimes, is no longer experimental engineer, National Motor Car Corp.

W. F. Herst, formerly general manager, M & S Gear Corp., Detroit, is factory manager, Wolverine Brass Works, Grand Rapids, Mich.

Benton Hopkins, formerly engineer and assistant secretary, Samuel Austin & Son Co., Cleveland, is with The Austin Co., Cleveland.

C. E. Hunt, formerly mechanical superintendent, is now service manager, Autocar Sales Co., New York.

C. E. Jacobs, formerly assistant chief engineer, King Motor Car Co., Detroit, is engineer, Detroit Tire Carrier Co., and also the Detroit Pitter Fan Co.

Charles George King, formerly gas engine expert, Woods Motor Vehicle Co., Chicago, is with the Double Seal Piston Ring Co.

Peter O. Krehbiel has severed his connections as chief engineer, The Parish Bingham Co., Cleveland.

William V. Lowe, formerly engineering department, Manning, Maxwell & Moore, Fitchburg, Mass., is with the John Bath Co., Worcester, Mass.

E. F. Lake, formerly metallurgical engineer, Detroit, is now assistant superintendent and metallurgist, Rich Tool Co., Chicago.

C. W. McKinley, formerly engineer, Willys-Overland Co., Toledo, Ohio, is consulting engineer with the same company at Washington.

E. C. Morse, formerly vice-president and general manager, Chalmers Motor Co., is representative, Willys-Overland Co., Washington.

C. A. Miller, formerly designer, Winton Co., Cleveland, is located at 1117 Eighth Street, N. W., Washington.

Joseph G. Murphy has severed his connections as factory manager, Pathfinder Motor Co., Indianapolis.

K. B. MacDonald, formerly vice-president, Curtiss Aeroplane & Motor Corp., is vice-president, Curtiss Engineering Corp., Garden City, N. Y.

Miles L. Matthews, formerly at Detroit, is with the Goodyear Tire & Rubber Co., Big Rapids, Mich.

B. Morgan, formerly at Newport, R. I., is now president, The Morgan Mfg. Co., Inc., Keene, N. H.

F. P. Nehrbas, formerly factory production manager, is now factory manager, Premier Motor Corp., Indianapolis.

J. J. O'Neill, formerly salesman, Laminated Shim Co., New York, and Charles Monson, Detroit, is now salesman with only the Laminated Shim Co.

Leonard D. Ormsby, formerly salesman and district manager, Ajax Rubber Co., New York, is now manager, Fisk Co., San Antonio, Tex.

D. M. Power, formerly engineer, Buick Motor Co., Flint, Mich., is now consulting and designing engineer at 43 St. Aubin Avenue, Detroit.

H. F. Patterson, formerly designer, Continental Motors Corp., Detroit, is chief engineer, Erie Motors Cultivator Co., Erie, Pa.

H. A. Raseley, formerly service manager, Australasian division, General Motors Export Co., New York, is eastern sales representative, Olds Motor Works, at New York.

Philip S. Rose, formerly editor, Clark Publishing Co., Madison, Wis., is now associate editor, *The Country Gentleman*, with headquarters at Chicago.

Louie W. Silvis, formerly service manager, Twin City Motor Car Co., Minneapolis, is instructor, Wm. Hood Dunwoody Institute, Minneapolis.

E. E. Sweet, formerly consulting engineer, Cadillac Motor Car Co., is now consulting engineer with Henry M. & Wilfred C. Leland, 2230 Dime Bank Bldg., Detroit.

Stanwood W. Sparrow, formerly assistant chief foreman, Metz Co., Waltham, Mass., is tool designer, R. D. Pollock Co., Boston, Mass.

H. Collier Smith, formerly at 807 Scotten Ave., Detroit, is president, The Quickwork Co., St. Marys, Ohio.

Wm. Taylor, formerly engineer, Saxon Motor Car Corp., Detroit, is now assistant chief engineer, The Militor Co., 47 W. 34th St., New York.

R. H. White, formerly president, The Cleveland Motor Plow Co., Euclid Village, Ohio, is president, The Cleveland Tractor Co., Cleveland.

R. E. Widrig, formerly chief draftsman, The Garford Motor Truck Co., Lima, Ohio, is in the engineering department, Locomobile Co. of America, Bridgeport, Conn.

THEODORE C. BRAUN

The death of Theodore C. Braun occurred Nov. 20 as a result of an accident in the Dixie Chemical Plant of the Platt & Washburn Co. at Petersburg, Va. In some unaccountable way Mr. Braun fell backward into a tank of caustic alkali solution, and, although he immediately sprang out of the tank, the paralyzing effect of the solution was such that he lived only ten hours.

Mr. Braun was born Aug. 1, 1891, in Jersey City, N. J. In 1912 he graduated, with a degree of M. E., from Sibley College, Cornell University.

His first position was in the drafting department of the Russell Motor Car Co. of Toronto, Canada. He then went into the parts assembly department of The Thomas B. Jeffery Co., Kenosha, Wis., next with the Testing Laboratory of the Automobile Club of America, New York, and finally became laboratory engineer with the Platt & Washburn Company. Mr. Braun, on May 20, 1913, was elected a junior member of the Society.

Applications *for* Membership

A list of current applications for membership is given below. The members are urged to send any pertinent information with regard to those whose names are given which the Council should have for consideration prior to their election. It is requested that such communications from members should be sent promptly.

ADAM, ROBERT MENAMIN, assistant chief draftsman, Edw. G. Budd Mfg. Co., *Philadelphia.*

ADAMS, COMFORT A., professor of engineering, Harvard University and Massachusetts Institute of Technology, *Cambridge, Mass.*

BAIER, R. E., purchasing agent, Sandow Motor Truck Co., *Chicago.*

CLARKE, THOMAS A., charge of Oldsmobile Sales Division, General Motors Export Co., 11 Broadway, *New York.*

COLE, RAYMOND A., engineer, Robert T. Pollock Co., *Boston.*

CONSOLIVER, EARL LESTER, instructor in mechanical drawing and machine design, University of Wisconsin, *Madison, Wis.*

COOK, J. C., engineer, Master Primer Co., *Detroit.*

CROWELL, WILLIAM P., testing engineer, aircraft division, Willys-Overland Co., *Toledo, Ohio.*

CUCURELLO, JOHN P., chief draftsman, The G & O Mfg. Co., *New Haven, Conn.*

DWYER, RAYMOND WILLIAM, assistant superintendent, engineer, Smith Wheel, Inc., *Syracuse, N. Y.*

FEHER, JOSEPH DAY, district sales manager, motor trucks, United Motors Co., 50th St. and 11th Ave., *New York.*

FLOGAUS, HOWARD A., engineer, Curtiss Aeroplane Co., *Buffalo.*

GARY, CLARENCE EDWARD, chief draftsman, Dyneto Electric Corp., *Syracuse, N. Y.*

HASHIMOTO, KENSKE, designing draftsman, aeronautical engineer, Parisano Aerial Navigation Co. of America, 1212 Candler Bldg., *New York.*

HEALD, H. P., layout man, Holt Mfg. Co., *Peoria, Ill.*

HELM, LOUIS P., production manager, Olympian Motors Co., *Pontiac, Mich.*

HENDRICKSON, ROBERT T., secretary, engineer, Hendrickson Motor Truck Co., *Chicago.*

HOWERTH, HERBERT JOSEPH, assistant industrial engineer, Pierce-Arrow Motor Car Co., *Buffalo.*

JOHNSTON, EDWARD A., manager, experimental department, International Harvester Co., *Chicago.*

KANTERS, LLOYD M., assistant engineer, Waukesha Motor Co., *Waukesha, Wis.*

KELSO, J. RUSSELL, owner, Kelso Mfg. Co., *Trenton, N. J.*

KRAUS, G. A., equipment engineer, Champion Spark Plug Co., *Chicago.*

LAFRANCE, C. H., president, C. H. LaFrance Sales Co., *Geneva, N. Y.*

LAUTH, FRED. PHILIP, engineering draftsman, Sandow Motor Truck Co., *Chicago.*

LORD, CHARLES EDWARD, patent attorney, International Harvester Co., *Chicago.*

LUNEKE, LOUIS C., aeronautical engineer, The Dayton Wright Airplane Co., *Dayton, Ohio.*

LUDLOW, ISRAEL, president, Aeronautical Equipment, Inc., 1 Wall St., *New York.*

MCNAULL, MONT W., vice-president, The McNaull Tire Co., *Toledo, Ohio.*

MEDER, CHARLES, president, general manager, Witherbee Storage Battery Co., Inc., 1904 Broadway, *New York.*

MEISTER, H. O. K., sales manager, Hyatt Roller Bearing Co., *Chicago.*

MILLER, ALBERT F., mechanical engineer, Field-Brundage Engine Works, *Jackson, Mich.*

MILLER, GEORGE B., president, Waterloo Gas Engine Co., *Waterloo, Iowa.*

MORELAND, WATT L., vice-president, general manager, Moreland Motor Truck Co., *Los Angeles, Cal.*

MORSE, EVERETT RALPH, first lieutenant, Ordnance Department, U. S. A., *Washington, D. C.*

OSTERHOFF, EDMUND E., assistant to chief draftsman, Nordyke & Marmon Co., *Indianapolis.*

PIGOTT, REGINALD J. S., superintendent, raw material department, Bridgeport Brass Works, *Bridgeport, Conn.*

PONTIUS, JOHN JOSEPH, Dayton, Ohio, representative, Locomobile Co. of America, *Cincinnati.*

PORTER, W. L., manager, president, W. L. Porter & Co., *Chicago.*

ROBBINS, LESTER M., sales, service manager, The Heisey-Robbins Co., *Cincinnati.*

ROGERS, WINFIELD S., chairman, board of directors, The Bantam Ball Bearing Co., *Bantam, Conn.*

RUTH, JOHN EDWARD, mechanical superintendent, Winton Motor Co., *Baltimore, Md.*

SANFORD, GLENN A., sales engineer, Perlman Rim Corp., *Jackson, Mich.*

SAUNDERSON, HENRY SOMERSET, business manager, General Motors, Ltd., *London, Eng.*

SCOTHORN, RODNEY JOSEPH, salesman, The Steel Products Co., *Cleveland.*

SEVALD, GEORGE VINCENT, salesman, The Steel Products Co., *Cleveland.*

STEHLE, FRANK K., treasurer, Bearings Co. of Pennsylvania, *Philadelphia.*

STEPHENS, EDWARD EVERETT, partner, The Double Seal Ring Co., *Denver, Col.*

SUDEN, RICHARD TUM, engineer, Kleiber & Co., Inc., *San Francisco.*

THOMSON, MALCOLM, engineer, General Electric Co., *Lynn, Mass.*

WATERHOUSE, HAROLD D., chief engineer, superintendent, Bay State Pump Co., *Boston.*

WEBB, WRIGHT, senior inspector, Signal Corps, Packard Motor Car Co., *Detroit.*

WHITE, FRANK M., assistant professor agricultural engineering, University of Wisconsin, *Madison, Wis.*

WILEY, CHARLES O., Northwestern representative, Byrne-Kingston Co., *Kokomo, Ind.*

WILLIAMS, LOUIS B., sales engineer, The Dayton Engineering Laboratories Co., *Dayton, Ohio.*

Applicants *Qualified*

The following list of applicants have qualified for admission to the Society between October 17 and November 13. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate; (Aff. Rep.) Affiliate Representative; (S. E.) Student Enrollment.

ADAMS, H. J. (A) purchasing agent, The Garford Motor Truck Co., *Lima, Ohio.*

ADAMS, H. W. (M) general manager, master mechanic, Common Sense Gas Tractor Co., 622 9th St. S. E., *Minneapolis.*

AMRINE, L. H. (A) vice-president, Scudder Motor Truck Co., 2815 Locust St., *St. Louis, Mo.*

ANDERSON, E. S. (J) mechanical engineer, student aviator, Aviation Section, Signal Corps, U. S. A., Rockwell Field, N. Island, *San Diego, Cal.*

APPLEYARD, GEORGE LUCAS (A) supervisor of service, Robinson Hardware Co., 361 Essex St., Lawrence, Mass., (mail) 455 Common St., *Lawrence, Mass.*

ARNOLD, EDWIN E. (Aff. Rep.) vice-president, Iron City Products Co., 7501 Thomas Blvd., *Pittsburgh, Pa.*

BARNES, NEVIN C. (S. E.) senior aeronautical engineer, University of Michigan, *Ann Arbor Mich.*, (mail) 708 Church St.

BOHAN, L. J. (A) manager, technical sales, Chicago office, Gurney Ball Bearing Co., Jamestown, N. Y., (mail) 4215 N. Lockwood Ave., *Chicago.*

BRINTON, WILLIAM C., JR. (M) chief engineer, Philips-Brinton Co., *Kennett Square, Pa.*

BENSON, BYRON D. (A) assistant treasurer, secretary, Tide Water Oil Co., 11 Broadway, *New York.*

BENNETT, H. W. (A) sales engineer, Sumter Electrical Co., 1466 Michigan Ave., *Chicago,* (mail) 900 Sunnyside Ave.

BARTON, A. W. (Aff. Rep.) foreman, Gas Traction Foundry Co., *Minneapolis.*

BERRY, HERBERT C. (A) designer, chief draftsman, Line Drive Tractor Co., *Milwaukee,* (mail) 522 M & M Bank Bldg., *Milwaukee.*

BROOKS, HENRY C., JR. (A) treasurer, Kessler Motor Co., 275-77 Vanilla Ave., *Detroit.*

BRASELTON, CHESTER H. (A) patent counsel, Electric Auto-Lite Corp., Willys-Overland Co., *Toledo, Ohio,* (mail) Willys-Overland Co.

BURTON, W. DEAN (M) aeronautical mechanical engineer, U. S. Signal Service, *Fort Omaha, Neb.*

BARNABY, RALPH S. (J) head of engineering department, Standard Aero Corp. of New York, *Elizabeth, N. J.,* (mail) 257 Hamilton Ave., *New Brighton, N. Y.*

BARE, E. L. (J) body draftsman, designer, Q. M. C., U. S. A., *Washington,* (mail) 1428 Clifton St.

BACON, CHARLES V. (M) consulting chemist, 3 Park Row, *New York.*

BEEMAN, E. R. (A) president, treasurer, Beeman Garden Tractor Co., 311 6th Ave., *Minneapolis.*

BISHOP, CHARLES D. (A) superintendent, Fargo Auto and Gas Engine School, *Fargo, N. D.*

BEIMLING, WILLIAM A. (M) mechanical engineer, Milwaukee Locomotive Mfg. Co., *Milwaukee,* (mail) 622 Bartlett Ave.

COATES, A. H. (A) Pacific coast representative, 41 Spear St., *San Francisco.*

CROCKETT, JAMES BARRET (A) director, Clyde Cars Co.; Menominee Electric Products Co.; J. B. Crockett Co., 44 Whitehall St., *New York,* (mail) J. B. Crockett Co.

COGGESHALL, GEORGE W. (M) in charge of engineering division and mill problems, The Institute of Industrial Research, 19th and B Sts., *Washington,* (mail) 2229 California St.

CLIPSON, F. C. (A) vice-president, sales manager, Pittsburgh-Paige Co., 4615 Baum Blvd., *Pittsburgh,* (mail) 5709 Darlington Road.

CONRADSON, PONTUS H. (M) chief chemist, Galena-Signal Oil Co., *Franklin, Pa.*

COHEN, EDWARD S. (M) general superintendent, Lycoming Foundry & Machine Co., *Williamsport, Pa.*

CLANCY, WILLIAM C. (M) mechanical engineer, acting as senior inspector of airplanes and airplane engines, Equipment Division, Inspection Section, Signal Corps, U. S. A., *Washington,* (mail) Aeroplane Engine Division, Nordyke & Marmon Co., *Indianapolis.*

CREAGER, E. F. (A) assistant factory manager, Remy Electric Division, United Motors Corp., *Anderson, Ind.*

CARNEY, JAMES M. (A) vice-president, general manager, The Hartford Auto Parts Co., 234 Market St., *Hartford, Conn.*

CORNELIUS, HERBERT Y. (A) production engineer, The Oakes Co., *Indianapolis.*

CLODIO, PAUL V. (A) president, The Houdaille Shock Absorber Co., Inc., 1737 Broadway, *New York.*

COX, HENRY G. (M) in charge of magneto department, International Harvester Co., 120th and Sagamore Sts., *Chicago.*

DANIEL, W. H. (M) engineer, Waterloo Gas Engine Co., *Waterloo, Iowa,* (mail) 147 Falls Ave.

DAYTON, WILLIAM E. (A) 306th Regt., Field Artillery, U. S. N. A., *Washington,* (mail) 5 Lawrence St., *Yonkers, N. Y.*

DEISHER, W. W. (A) service manager, International Motor Co., 294 Laurier Ave. W., *Ottawa, Can.*

ENSIGN, O. H. (M) engineer, president, Ensign Carburetor Co., 149 W. Pico St., *Los Angeles,* (mail) 903 Oakland Ave., *Pasadena, Cal.*

ERICSON, JOHN (M) engine designer, 1237 Wrightwood Ave., *Chicago.*

EDENS, H. N. (M) factory manager, chief engineer, John Lauson Mfg. Co., *New Holstein, Wis.*

EVANS, R. T. (A) chief engineer, Evans Mfg. Co., *Hudson, Ohio.*

EKSTROM, ERIC S. (A) secretary, Mechanics Machine Co., *Rockford, Ill.*

FURRY, EDWARD BLAINE (A) vice-president, sales manager, The Union Forging Co., 500 Railroad St., *Union, N. Y.,* (mail) Box 513.

FAUNTLEROY, THOMAS T. (A) sales engineer, Gurney Ball Bearing Co., *Jamestown, N. Y.,* (mail) 2 Rector St., *New York.*

FRANTZ, J. R. (M) vice-president, superintendent, Le Roi Co., *Milwaukee,* (mail) 664 73d Ave., *West Allis, Wis.*

FUNKEY, LYMAN H. (S. E.) instructor in stationary gas engines, automobile engineer, Central Continuation School, Stroh Bldg., *Milwaukee.*

GUTHRIE, H. J. (A) president, Platt & Washburn Refining Co., 11 Broadway, *New York.*

GAS TRACTION FOUNDRY CO. (Aff. Mem.) *Minneapolis.* Representatives: D. A. Potter, president; O. W. Potter, vice-president; A. W. Barton, foreman.

GRAD, LEO M. (J) chief engineer, Karry-Lode Industrial Truck Co., Inc., 98-100 Nott Ave., *Long Island City, N. Y.*, (mail) 63 Lenox Ave., *New York.*

GUYTON, P. W. (A) superintendent, Ford Motor Co., 920 S. Broadway, *Denver, Col.*

HEER, C. (A) manager, The Reliable Engine Co., *Portsmouth, Ohio.*

HAZEN, A. J. (A) assistant chief draftsman, Kissel Motor Car Co., *Hartford, Wis.*, (mail) 195 Seventh St.

HOYT, FRED A. (J) electrical engineer, Menominee Electric Products, Inc., 44 Whitehall St., *New York*, (mail) 192 Prospect St., *East Orange, N. J.*

HENNICKE, CARL R. (J) assistant engineer, Lippard-Stewart Motor Car Co., 226 W. Utica St., *Buffalo*, (mail) 68 Chatham St.

HOOTH, KARL W. (J) chief draftsman, assistant engineer, Fuller & Sons Mfg. Co., *Kalamazoo, Mich.*, (mail) 515 Pine St.

HOLMES, ARTHUR (M) president, The Holmes Automobile Co., *Canton, Ohio.*

HART, GERALD W. (M) president, The Hart Mfg. Co., *Hartford, Conn.*

HANSCOM, CLARENCE D. (S. E.) instructor, Massachusetts Institute of Technology, *Cambridge, Mass.* (mail) 499 Beacon St., *Boston.*

HEATH, FRANK C. (A) factory manager, Federal Brass Works, 364 Trombly Ave., *Detroit.*

IRON CITY PRODUCTS CO. (Aff. Mem.) 7501 Thomas Blvd., *Pittsburgh.* Representatives: Edward E. McCoy, president; Edwin E. Arnold, vice-president; Stephen R. Van de Water, engineering department.

IAGO, NORMAN JOHN (J) in charge of testing department, Findeisen & Kropf Mfg. Co., *Chicago*, (mail) Riverside Hotel, *Riverside, Ill.*

JONES, T. A. (A) general manager, treasurer, W. A. Jones Foundry & Machine Co., 4401 W. 12th St., *Chicago.*

JACO, E. L. (A) manager, tractor department, F. C. Austin Drainage Excavator Co., Railway Exchange Bldg., *Chicago.*

JENKINS, ELBERT J. (M) president, general manager, assistant in engineering department, The Four Drive Tractor Co., 949 E. Maple St., *Big Rapids, Mich.*

KOFFER, ALBERT E. (A) sales department engineer, The Dayton Engineering Laboratories Co., *Dayton, Ohio*, (mail) 14 N. Robert Blvd.

KESSLER, MARTIN C. (M) president, Kessler Motor Co., 275 Vanilla Ave., *Detroit.*

KAISER, WILLIAM L. (A) sales engineer, Sumter Electrical Co., 1466 Michigan Ave., *Chicago.*

LANKERING, R. T. (S. E.) mechanical engineering student, Stevens Institute of Technology, *Hoboken, N. J.*, (mail) 472 Park Ave., *Paterson, N. J.*

LAKE, HENRY STEERS (A) president, Lake Sales Co., 1947 Broadway, *New York.*

LEVY, ALFRED K. (A) planner, Otis Elevator Co., *Yonkers, N. Y.*, (mail) 320 St. Nicholas Ave., *New York.*

LIPE, W. C. (M) vice-president, Brown-Lipe Gear Co., *Syracuse, N. Y.*, (mail) Hotel Raleigh, *Washington.*

MCCOY, EDWIN E. (Aff. Rep.) president, Iron City Products Co., 7501 Thomas Blvd., *Pittsburgh.*

MCINTYRE, JOHN W. (S. E.) draftsman, Auburn Automobile Co., *Auburn, Ind.*, (mail) 703 S. Main St.

MOONEY, W. H. (A) sales department engineer, The Dayton Engineering Laboratories Co., *Dayton, Ohio*, (mail) 214 E. Herman Ave.

MEARS, B. B. (M) lubricator engineer, Vacuum Oil Co., *New York*, (mail) 2366 Grand Concourse.

MOLLOY, EDDIE (M) chief engineer, Loening Aeronautical Engineering Corp., *Long Island City, N. Y.*, (mail) 125 Hanover St., *Elmhurst, N. Y.*

MIKESH, M. A. (M) assistant inspector of engineering material, Bureau of Steam Engineering, U. S. Navy, 711 Merrill Bldg., *Milwaukee.*

MOTT, THOS. T. (A) technical man, Chalmers Motor Co., *Detroit.*

NERACHER, W. A. (A) vice-president, manager, Neracher & Fritzsche, Caxton Bldg., *Cleveland.*

NORMAN, FREDERICK D. (Aff. Rep.) Bosch Magneto Co., *Springfield, Mass.*

OCHTMAN, LEONARD, JR. (J) assistant to chief draftsman, Van Blerck Motor Co., *Monroe, Mich.*, (mail) 59 S. Macomb St.

POWERS, H. A. (A) purchasing agent, Yuba Mfg. Co., *Marysville, Cal.*

POTTER, D. A. (Aff. Rep.) president, Gas Traction Foundry Co., *Minneapolis.*

POTTER, O. W. (Aff. Rep.) vice-president, Gas Traction Co., *Minneapolis.*

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Page 46, col. 2, line 40, A. T. Brown should read J. S. Brown.

Page 52, col. 2, line 53, A. T. Brown should read J. S. Brown.

Page 189, Fig. 7, letters should read *h* to *a* instead of *a* to *h*.

Page 300, col. 1, line 16; col. 2, line 1, G. D. Brown should read J. S. Brown.

Page 301, col. 1, line 12; col. 2, line 41, G. D. Brown should read J. S. Brown.

Page 303, Fig. 2, should read, Fig. 4.

Page 304, Fig. 4, should read, Fig. 2.

Page 311, Fig. 15, $^{\pi}$ should be r.

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Book Reviews *for* S. A. E. Members

This section of the S. A. E. JOURNAL is devoted to the technical books considered to be of interest to members of the Society. Such books will be described briefly as soon as possible after their receipt, the purpose being to show concisely the general nature of their contents and to give an estimate of their value.

ACQUIRING WINGS. By William B. Stout, technical advisor, International Aircraft Standards Board. Published, 1917, by Moffat, Yard & Co., 120 W. Thirty-second St., New York. Cloth, 4½ by 7 in., 57 pages, 12 ill. Price $0.75.

LEARNING TO FLY IN THE U. S. ARMY. By E. M. Fales, professor of mechanical engineering, Chair of Aeronautics, University of Illinois. Published, 1917, by McGraw-Hill Book Co., Inc., 239 W. Thirty-ninth St., New York. Cloth, 4½ by 7 in., 180 pages, 37 ill. Price $1.50.

At the present time many members of the Society are interested in knowing just how flying is done. What with building engines and other parts, a large number of S. A. E. members are directly interested in aeronautical engineering. This does not consider, of course, the many members connected with companies making the finished product.

Two small volumes recently issued will be of considerable use to the members of the Society in acquiring the knowledge of the terms commonly used in aircraft construction and in finding out just how the machines are operated.

Mr. Stout's book was written while he was chief engineer of the Aircraft Division of the Packard Motor Car Company and was intended for the use of a force of men sent abroad by the Government early in the war to study aircraft production.

In an intimate way he takes up the elementary principles of the modern airplane, showing by means of an ordinary blotter just how the air sustains the machine. He then goes on to describe the general theory of airplane wings and gives rather completely the nomenclature used with different plane constructions.

The subject of airplane engines is covered briefly. Considerable attention is paid to the various systems of control used in modern aircraft, these being described by means of the text and by carefully worked out illustrations.

In fact, the book is exceptionally well illustrated. While line drawings are used exclusively, these are worked in so as to prove of maximum value for a complete understanding of the text.

The book in general follows the nomenclature recommended by the National Advisory Committee for Aeronautics. In the illustration shown on page 23, however, the draftsman has evidently followed his own inclinations, since the word "span" is used instead of "spread," which is used consistently in the text.

To those interested in flying terms and in a non-technical presentation of the principles underlying flying, Mr. Stout's book should be exceedingly valuable.

Professor Fales has been in charge of one of the United States Ground Schools of Military Aeronautics and has therefore had unusual opportunity to judge of just what information is necessary for the non-technical student aviator. He has attempted to present a manual of aviation practice containing the fundamentals of flying that the aviator must know in order to operate his machine efficiently.

His book opens with a chapter devoted to the history of aviation, in which the work done by such pioneers as Langley, Lillienthal, Chanute, the Wright brothers, Bleriot and others is described. Then follows an outline of the requirements of the military airplane. The functions of the different types of machines are explained.

The statement is made that airplane engines must be improved and a large number of landing fields must be developed in order for aircraft to have a commercial future after the war. It would seem that the author has put the cart before the horse in suggesting that landing fields should be developed in order to meet necessities of airplane design. Of course, this is necessary under war conditions, but as far as the commercial machine is concerned it would seem that the design itself should be improved so that landings can be made in a comparatively small space that can readily be found.

The main purpose of the book, of course, is to give the student an outline of the military uses of aircraft. The principles of flight are dealt with in considerable length, although no effort is made to cover any semi-technical points. The student is given directions for starting his machine, and the precautions to avoid poor landing are itemized.

An interesting chapter is devoted to cross-country flying. The up-to-date methods of aerial navigation are outlined and devices used to help the aviator are described. The chapter devoted to rigging of airplanes consists mainly of the nomenclature of important parts. The book is concluded by chapters relating to materials of construction and to methods of erection.

Photographs and line drawings are used to a large extent to illustrate the operation and construction of the machine. It is to be regretted that no index is included in the book, inasmuch as it would make it much more useful to the student or to others interested in this subject.

GLOSSARY OF AVIATION TERMS, by Lieut. Victor W. Pagé and Lieut. Paul Montariol. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York. Paper, 6 by 9 in., 94 pages, 14 ill. Price, $1.

Much of the instruction given at American ground schools and flying fields will probably be completed on French territory. This book has been written as an aid in facilitating intercourse between the French and English pilots and mechanics. As the title indicates, the booklet is more of a glossary or list of words than a dictionary, being intended only for the use of those already familiar with aviation. The lists were prepared originally for use in teaching classes at the Signal Corps Aviation School, Mineola, L. I. The authors state that some of the equivalents may not be literally correct but that they have been selected with a view to listing only terms in common, everyday use.

The cooperation of Lieutenant Montariol, of the French Flying Corps, insures that the equivalents will conform with the generally accepted practice abroad. It is hoped that this work will be of value in securing closer cooperation and more intelligent discussion of aviation

(*Continued on page* 42, *Advertising Section*)

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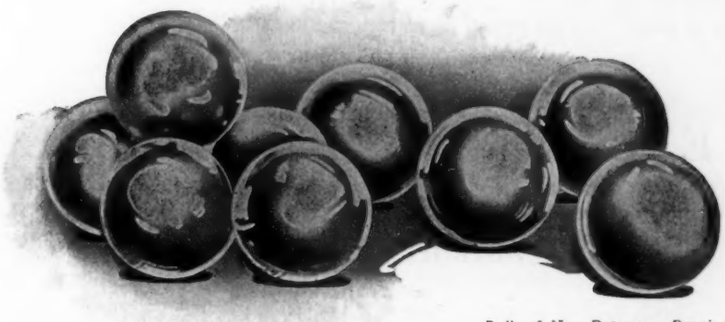

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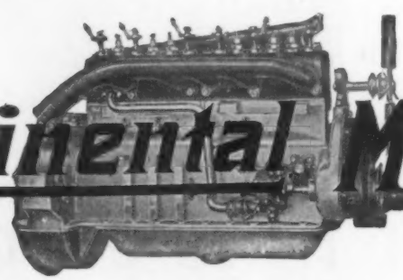

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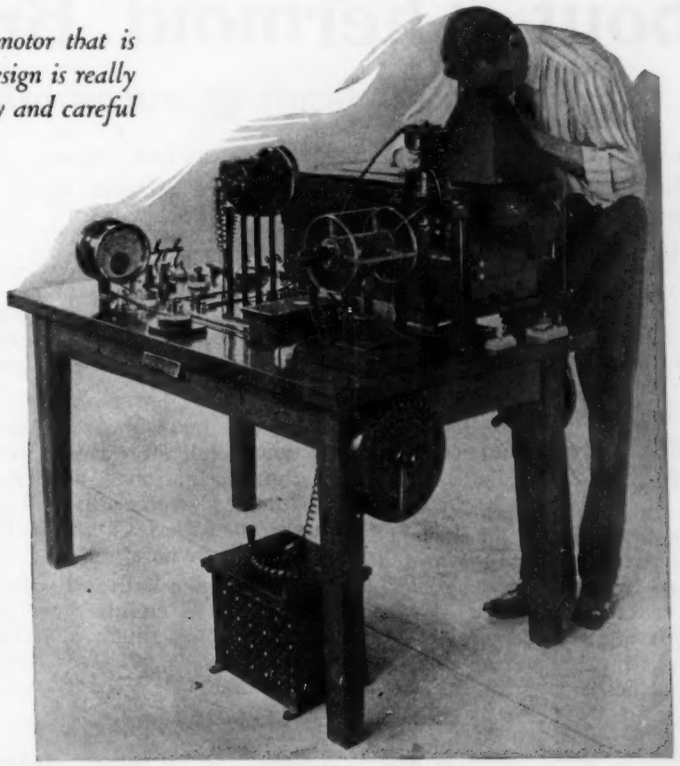

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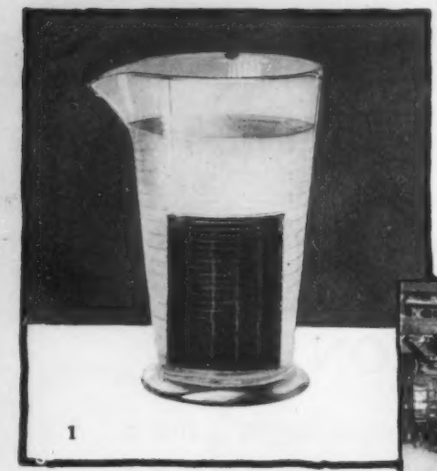

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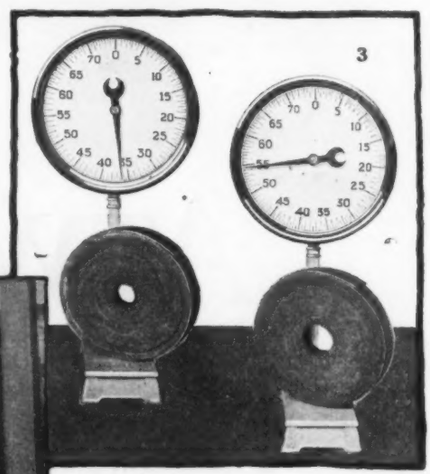

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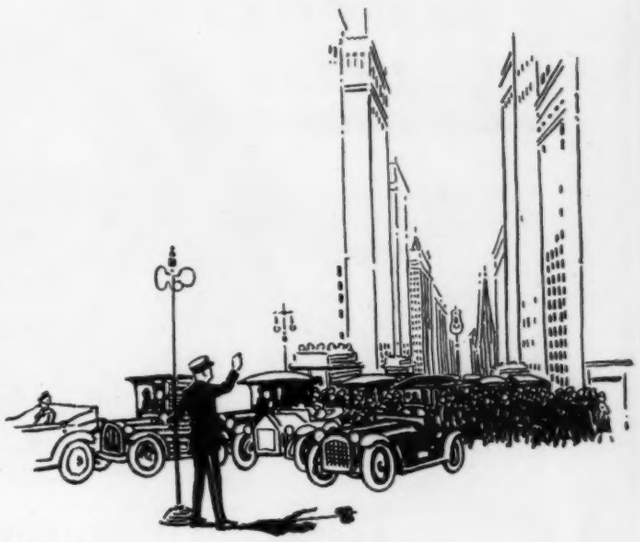

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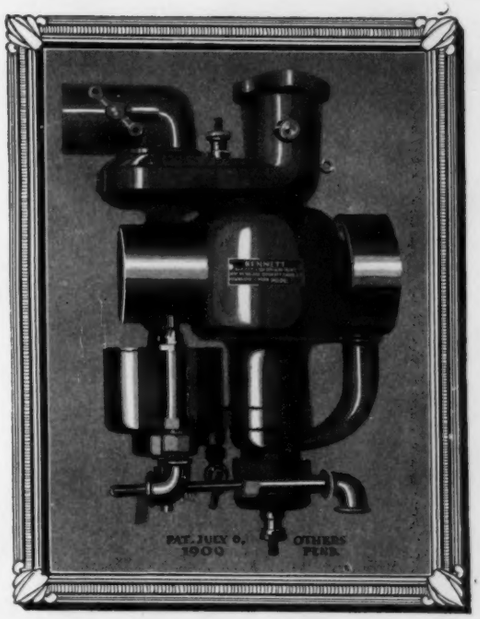

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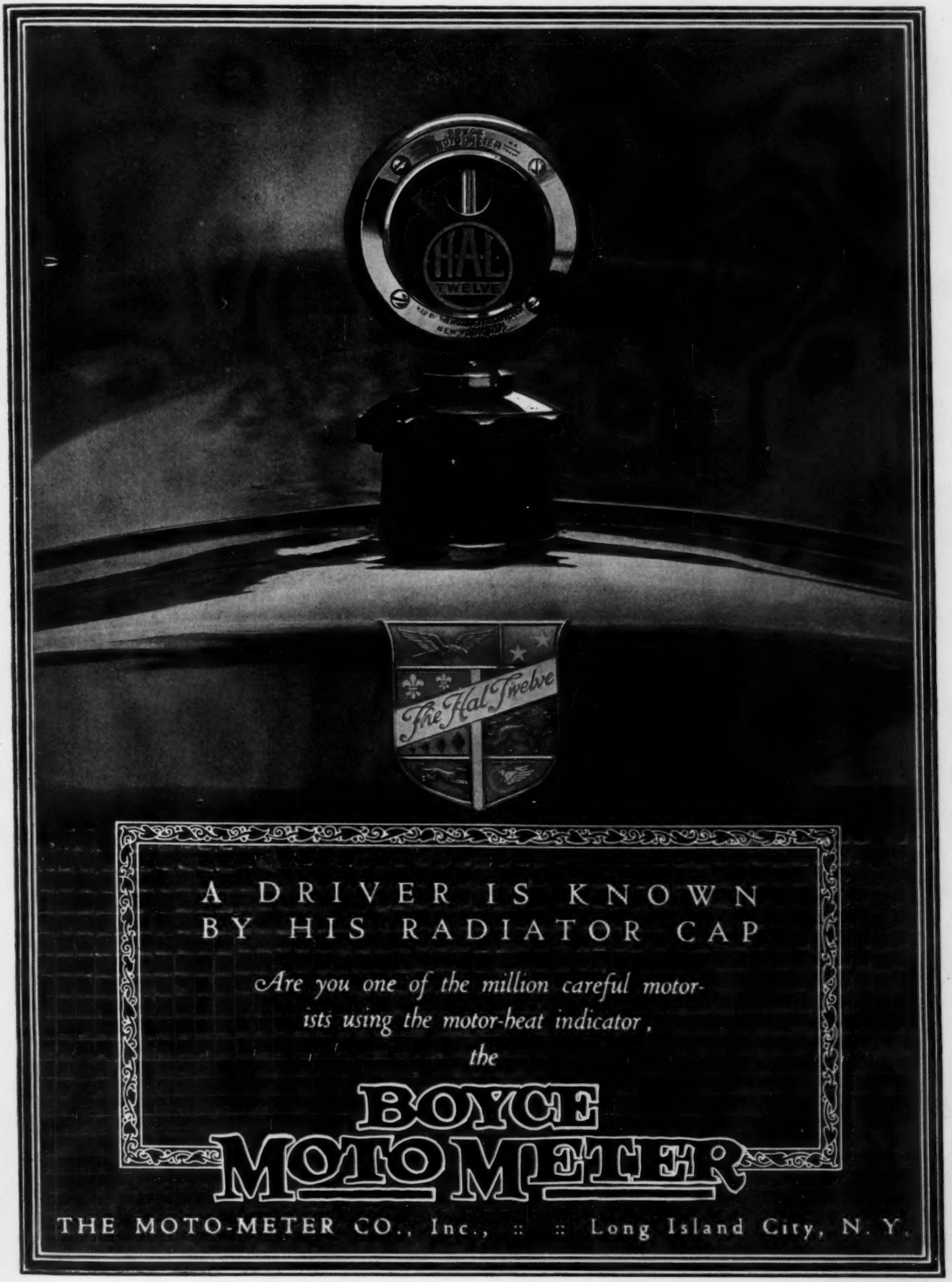
WILCOX-BENNETT CARBURETOR CO.
Specialists in Kerosene Carburetors

Minneapolis

The Bennett Carburetor Air Cleaner

SRB
MAXIMUM
SILENT ANNULAR
BALL BEARINGS
By using the maximum number of balls in these bearings the load on each ball is greatly reduced, thereby adding appreciably to the efficiency and long life of the bearing.
S R B Bearings are designed to meet every requirement, large or small. Let our Engineering Department help you select the type that will give you the greatest service.
Comparative tables showing the most commonly used sizes will be sent on request
STANDARD ROLLER BEARING CO.
PHILADELPHIA, PA., U.S.A.
BRANCHES:
DETROIT, 936 Woodward Ave.
CHICAGO, 2206 Michigan Ave.
INDIANAPOLIS, 822 Hume Mansur Bldg.
BOSTON, 163 Massachusetts Ave.
Makers of S R B Annular Ball Bearings, Ball Thrust Bearings, Taper Roller Bearings, Steel Balls and Rudge-Whitworth Wire Wheels.
Head Sales Office for MAYO Radiators Made by Mayo Radiator Division Martin Rockwell Corporation New Haven, Conn.



A DRIVER IS KNOWN
BY HIS RADIATOR CAP

Are you one of the million careful motor-
ists using the motor-heat indicator,
the

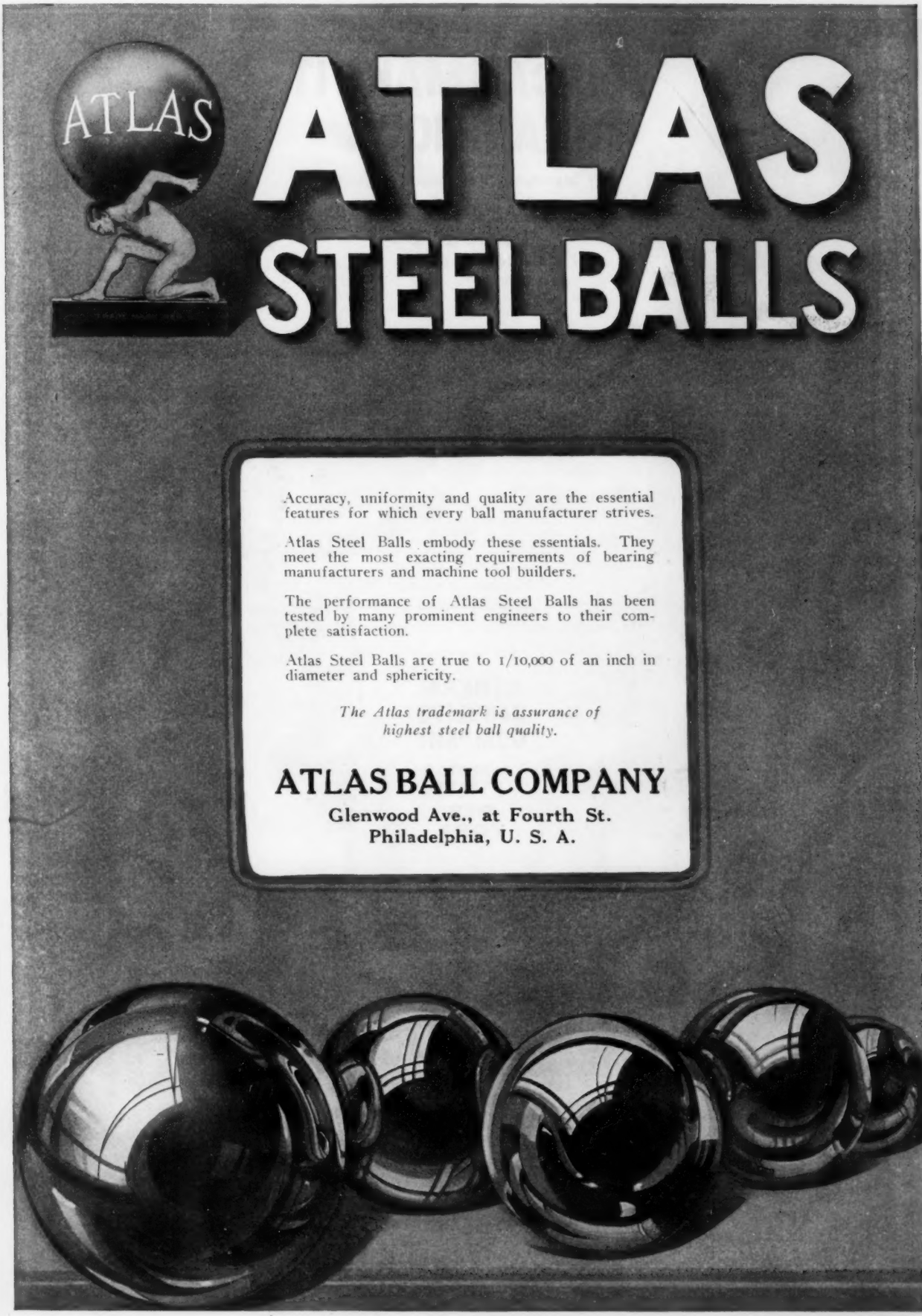
BOYCE
MOTOMETER

THE MOTO-METER CO., Inc., :: :: Long Island City, N. Y.

Where the Slightest Flaw Invites Destruction

IN the aeroplane—where the slighest defect in any part or material invites almost certain destruction and loss of life—you usually find Hess-Bright Ball Bearings. They are essential to machines in which dependability, endurance and faultless operation are imperative, and are invariably an indication of conscientious construction. The same is true regarding motor cars — the better are Hess-Bright equipped.

Where Performance takes Preference over Price


ATLAS
ATLAS
STEEL BALLS
Accuracy, uniformity and quality are the essential features for which every ball manufacturer strives.
Atlas Steel Balls embody these essentials. They meet the most exacting requirements of bearing manufacturers and machine tool builders.
The performance of Atlas Steel Balls has been tested by many prominent engineers to their complete satisfaction.
Atlas Steel Balls are true to 1/10,000 of an inch in diameter and sphericity.
The Atlas trademark is assurance of highest steel ball quality.
ATLAS BALL COMPANY
Glenwood Ave., at Fourth St.
Philadelphia, U. S. A.

YOU CAN MAKE IT UNANIMOUS

Mr. Manufacturer of electric systems.

If you are one of the very few who have not yet adapted

BAKELITE
Moulded Insulation

let your eye run over these pictures—they will tell you how nearly universal is the use of Bakelite for these systems.

If, however, you find among them your own name and apparatus, you will be strengthened in your belief that your judgment was good.

You know that others as well as yourself, find in Bakelite heat resistance, mechanical and dielectric strength, resistance to hot oils and corrosive influences.

Surely such a combination of qualities is unique in any insulation. When metal inserts are required, no material excels Bakelite. The metal parts are moulded in, accurately positioned, without assembly costs.

Other uses of Bakelite are explained in our publication "Bakelite on the Automobile."

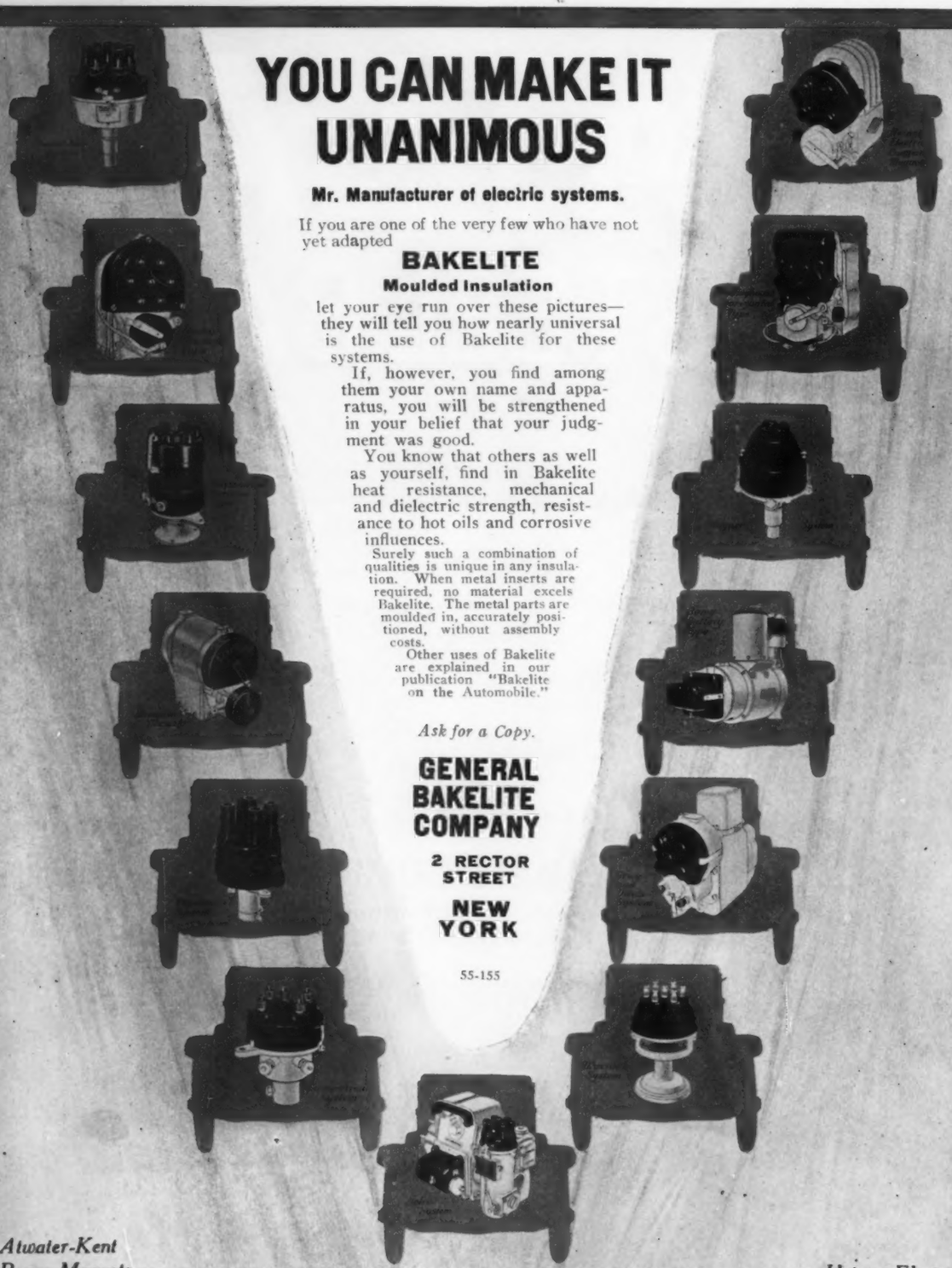
Ask for a Copy.

GENERAL BAKELITE COMPANY

2 RECTOR STREET

NEW YORK

55-155



Atwater-Kent
Remy Magneto
Westinghouse Vertical
Eisemann
Rhoades
Connecticut
Delco

Heinze Electric
Westinghouse Horizontal
Wagner
Remy Battery
Gray and Davis
Macnish

BAKELITE
MOLDED INSULATION

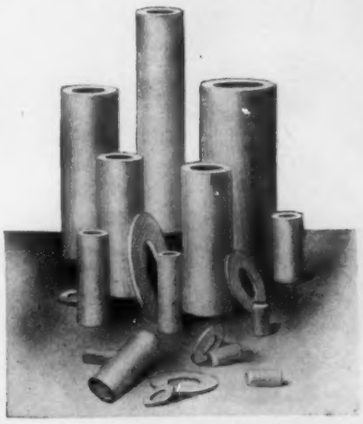
Ten Bullseyes

Against Your Overhead is the Perfect Score of

ARGUTO Oilless Bearings

1. **Life Hazard—Lower rates for compensation insurance.**
2. **Fire Risk—No oil dripping or soaked waste.**
3. **Long Life—They run 8 to 15 years without attention.**
4. **Upkeep Saving—No oil, labor, repairs or worry.**
5. **Adaptability—Suitable for nearly any light duty mechanism.**
6. **Loose Pulleys—Arguto Bearings won't wear countershaft.**
7. **Cleanliness—No oil spattered materials or fabrics.**
8. **40% to 50% increased wear from leather belting.**
9. **True Economy—Increased efficiency of production.**
10. **Dependability—The prestige of 25 years' endorsement by thousands of engineers and users.**

From looms to automobiles, Arguto Oilless Bearings find their use. There are so many applications for them that if, you have bearing problems which in any way affect the efficient production of your equipment or the smooth operation of your products, you should let our engineers tell you what you could expect from Arguto Oilless Bearings. Their help is our service—now as well as after you begin to use Arguto.



Arguto Oilless Bearing Co.
156 Berkley Street
Wayne Junction, Philadelphia

Outwears the Best Bronze Metal

Arguto
NON—METALLIC

Smoother Than Grease

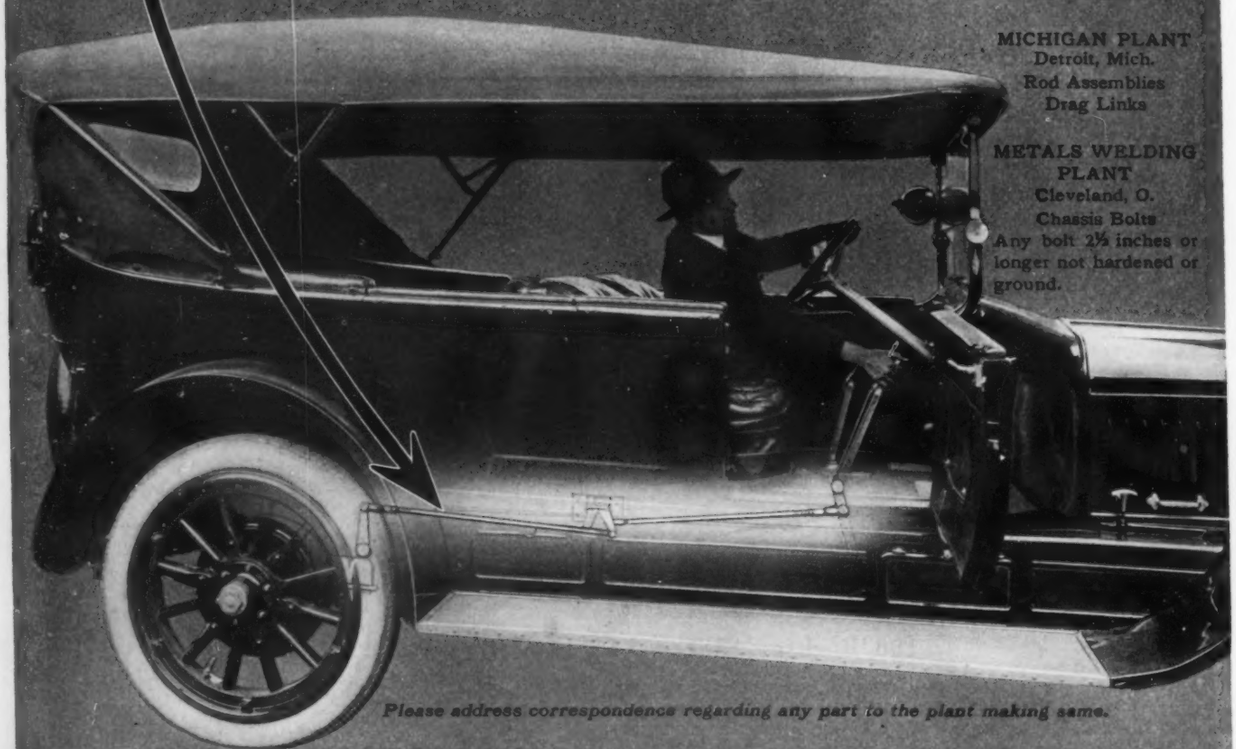
Rod Assemblies

No workmanship can be too good—
no material too costly where safety
depends directly on it

MAIN PLANT
Cleveland, O.
Poppet Valves
King Bolts
Spring Bolts
Push Rods

MICHIGAN PLANT
Detroit, Mich.
Rod Assemblies
Drag Links

METALS WELDING PLANT
Cleveland, O.
Chassis Bolts
Any bolt 2½ inches or longer not hardened or ground.



Please address correspondence regarding any part to the plant making same.

The Steel Products Co.
A DEPARTMENT OF YOUR PLANT

COUNTERBALANCED

Patented July 10, 1917

AVIATION CRANKSHAFTS

We have shipped 57,550 Counterbalanced Crankshafts to Dec. 1, 1917

THE PARK DROP FORGE Co.

CLEVELAND

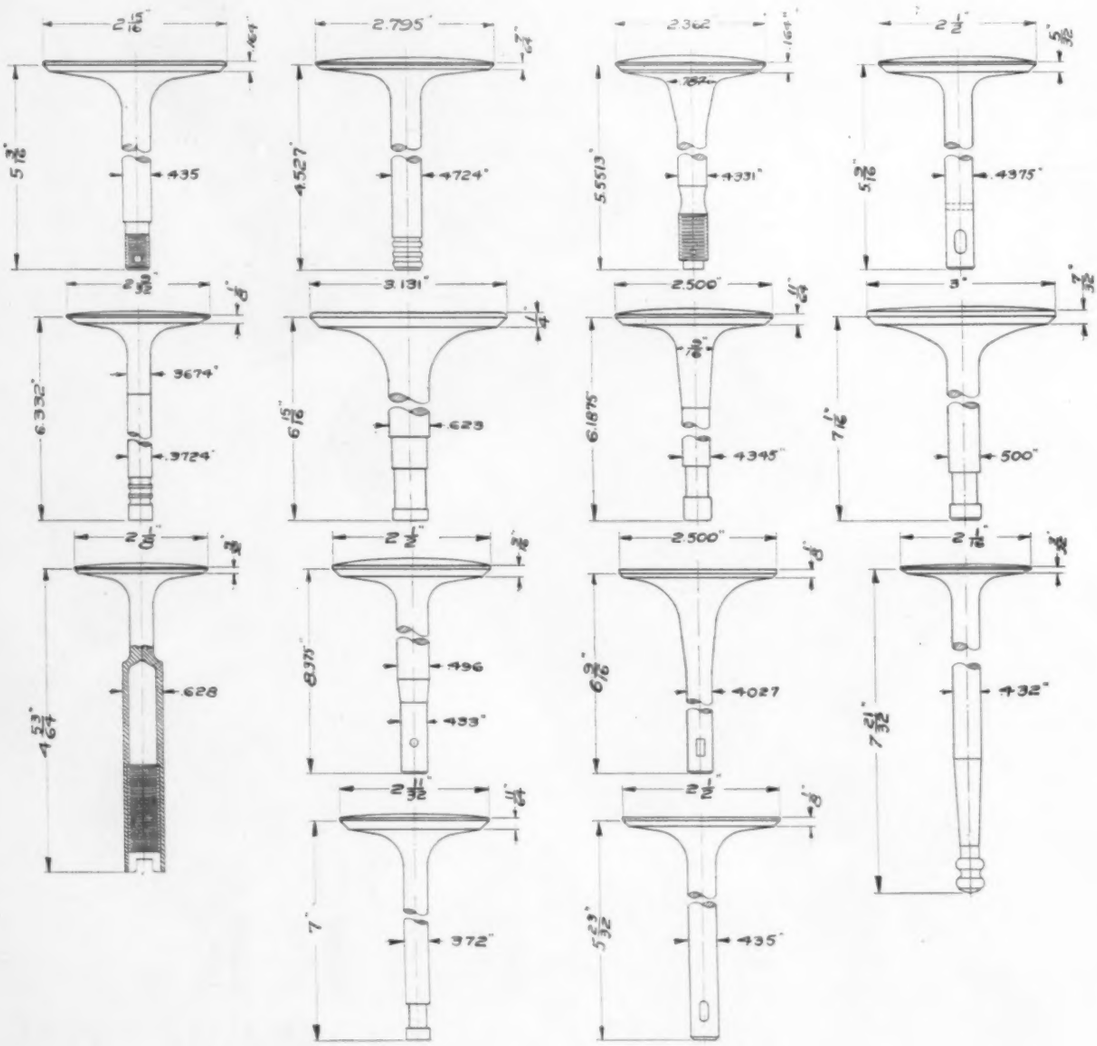
RICH TOOL COMPANY

Kresge Building, Detroit, Mich. **Railway Exchange Bldg., Chicago, Ill.**

The cuts below represent valves used in some of the best known present day Aeroplane, Motor-Boat and Racing Automobile Engines. They are all products of this company and most of them have been produced in large quantities and have, therefore, been thoroughly tested in service.

Needless to say, they are all Tungsten Steel, but we also make one-piece forged valves of all other commonly used Alloy Steels in the manufacture of which we exercise the same care as is used in higher priced Tungsten Valve materials.

One of the newer types of valves which we have been making in very large quantities for the past year is our Hi-Chromium Valve, which has some very remarkable properties. It is for some purposes an excellent valve and we solicit inquiries from those who are troubled by a persistent burning away of the seats of the valves in their motors.



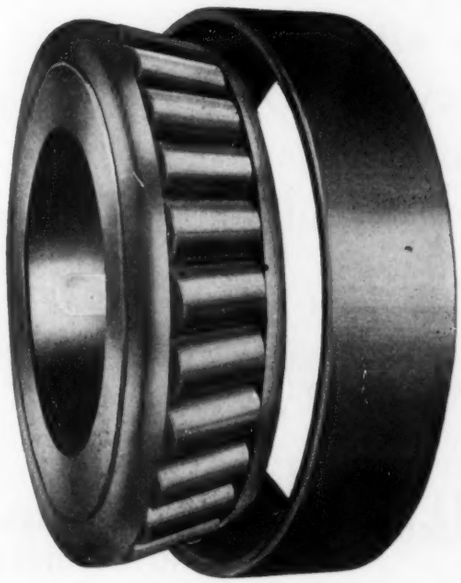
Our Engineering Department is at your service on all questions concerning suitability of material and design.

WRIGHT *Taper Roller* BEARINGS

The absence of any cage or other auxiliary structure saves the Wright bearing from all troubles due to "cage" distortion.

The braking action of cages, which is always exerted, on rolls is entirely eliminated in this type of bearing, thus allowing proper functioning of the rolls under all conditions.

WRIGHT ROLLER BEARING CO.
CROZER BUILDING PHILADELPHIA, PA.
Factory: Spring City, Pa.



"WHITNEY"
KEY-SEAT CUTTERS

For the Woodruff System of Keying

BE SURE AND GET OUR PRICES

Prompt Deliveries in either Carbon or High Speed Steel

The completion of the latest addition to our factory has enabled us to reorganize the department in which we manufacture our "Whitney" Cutters for the Woodruff System of Keying.

In this reorganization we have made many Changes and improvements in our equipment and our methods of manufacture. Our production has been increased, our prices have been reduced, and our facilities for handling business made more nearly perfect.

We strongly believe that it will be to your interest to acquaint yourself with our latest prices.

Material the Best Obtainable
Unsurpassed in Efficiency and Durability
Centered at Both Ends
Unsurpassed in Accuracy and Finish

"WHITNEY" KEYS

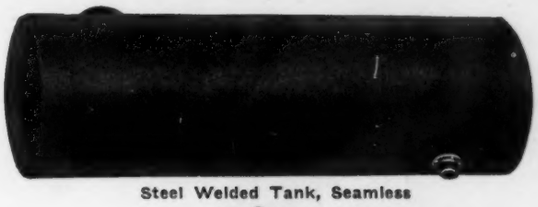
Are made in sizes to correspond with "Whitney" Cutters and can be furnished in either High Carbon or Nickel Steel.

THE WHITNEY MFG. CO., Hartford, Conn.

CHAINS **KEYS AND CUTTERS** **HAND MILLING MACHINES**

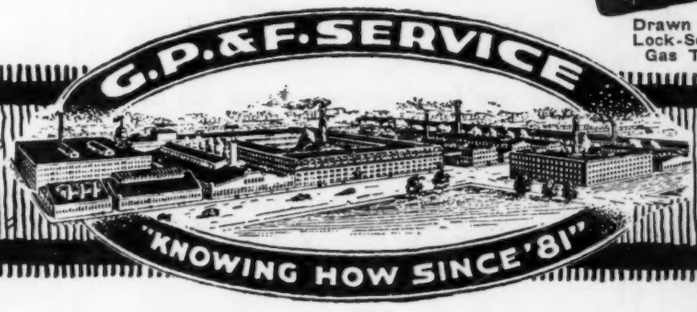
GASOLINE TANKS
MADE TO YOUR SPECIFICATIONS

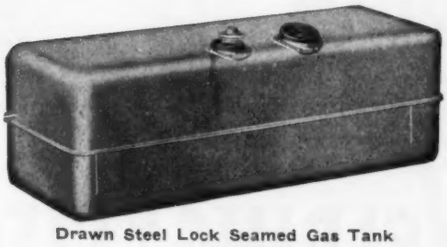
The manufacture of gasoline tanks is a distinct problem in itself—a problem which can be efficiently and economically solved for you by



Steel Welded Tank, Seamless

Drawn Steel Lock-Seamed Gas Tank





Drawn Steel Lock Seamed Gas Tank

Terne Plate, Built-Up Tank

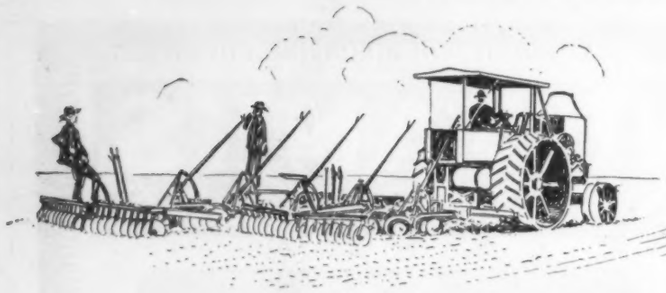
Our special tank department is thoroughly equipped to turn out war time orders of any size—on either welded or locked seamed tanks—any type—and do it promptly.

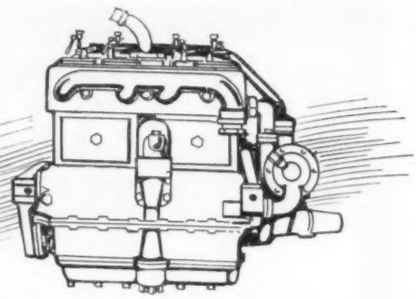
36 years of manufacturing experience have perfected an organization fully capable of meeting an emergency, and 15 acres of floor space provides ample capacity for handling any proposition, no matter how large.

It will pay you to investigate G. P. & F. Service. Send sample or blue print for estimate.

GEUDER, PAESCHKE & FREY CO.,

1365-1700 St. Paul Avenue **Milwaukee, Wis.**



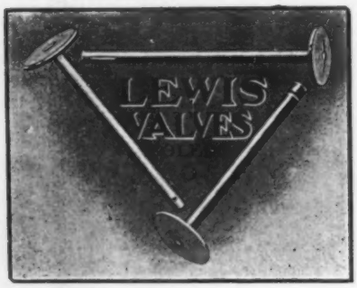


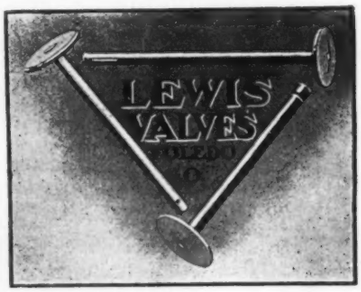
Lewis Valves

Are still holding their own all along the line, except in some sections they are forcing the enemy out of the trenches and causing them to retreat in disorder, as they are being used in the big tanks at the front.

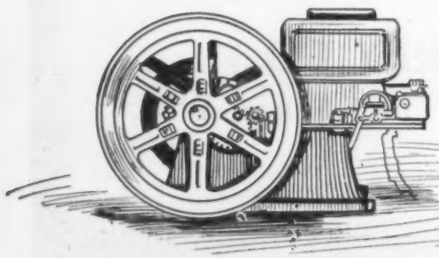
Why not investigate

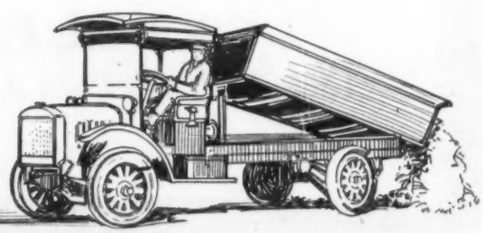
The
Lewis Steel Products Co.
Successors to





THE LEWIS ELECTRIC WELDING & MFG. CO.
TOLEDO, OHIO





Reaming vs Hand Scraping

Acquainting you with the Martell Adjustable Reamer

—an accurately adjustable reamer and adjustable bushings for aligning and finishing crank case bearings of internal combustion engines or any series of bearings which should be in perfect alignment.

By its use, all bearings in the same line are reamed and finished simultaneously—an adjustable centering mechanism providing the means for securing the correct alignment of cutting tools.

The design and alignment of the reamer blades absolutely eliminate the possibility of "chatter" or "waves" and insure perfectly finished bearings which are superior to a scraped surface.

By means of a micrometer adjustment, the diameter of the reamer blades may be increased or decreased at will with definite precision. It is also possible to caliper the blades in position for checking the size.

This method of line reaming will produce a better job than can possibly be obtained by hand scraping, and a saving of from 50 per cent to 80 per cent in the time required has been effected in many cases.

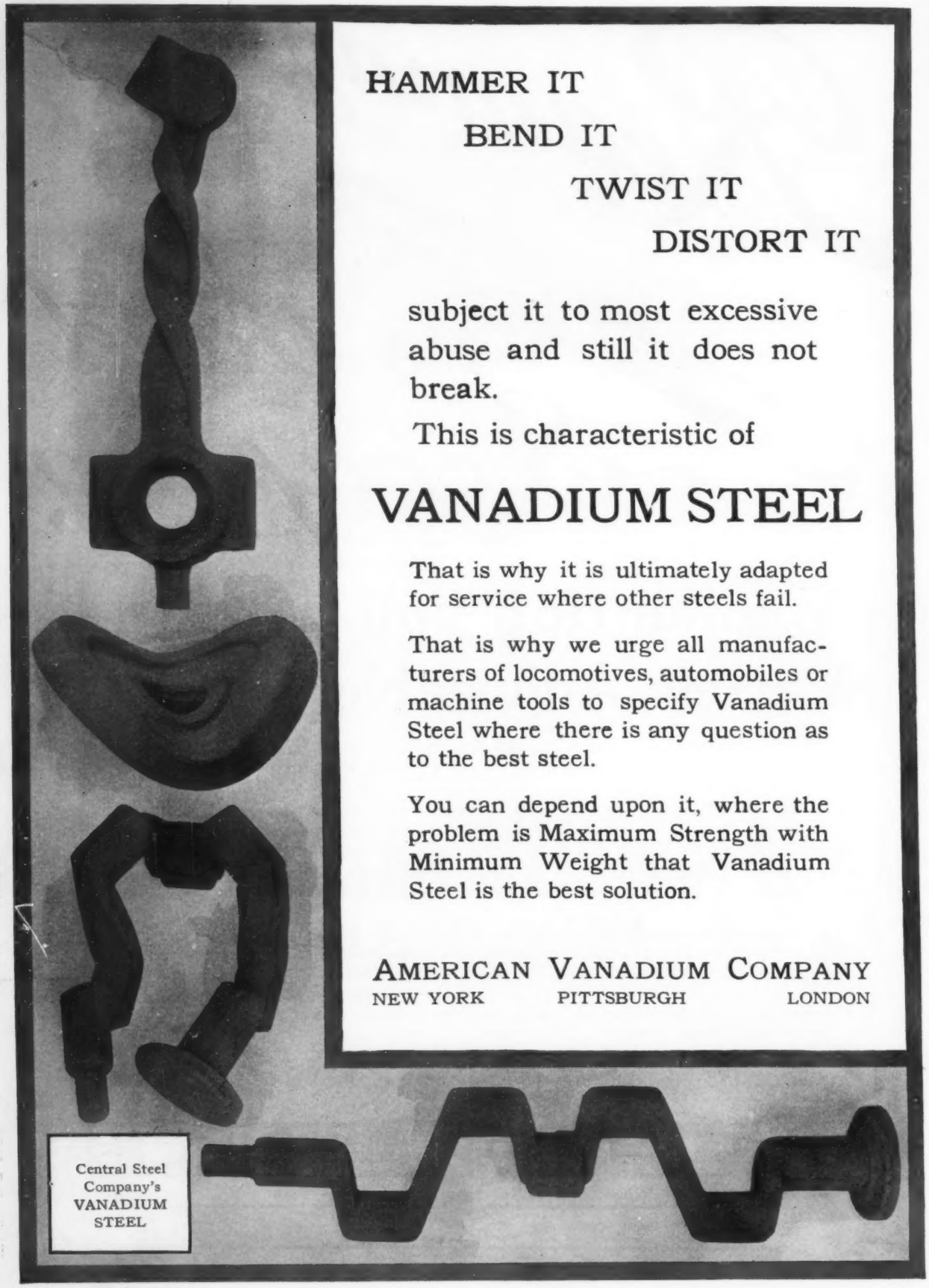
Let us make a proposition covering your particular requirements.

TAFT-PEIRCE

Woonsocket, R.I., U.S.A.

New York Office, Woolworth Bldg. **Detroit Office, Majestic Bldg.**

3001



HAMMER IT

BEND IT

TWIST IT

DISTORT IT

subject it to most excessive abuse and still it does not break.

This is characteristic of

VANADIUM STEEL

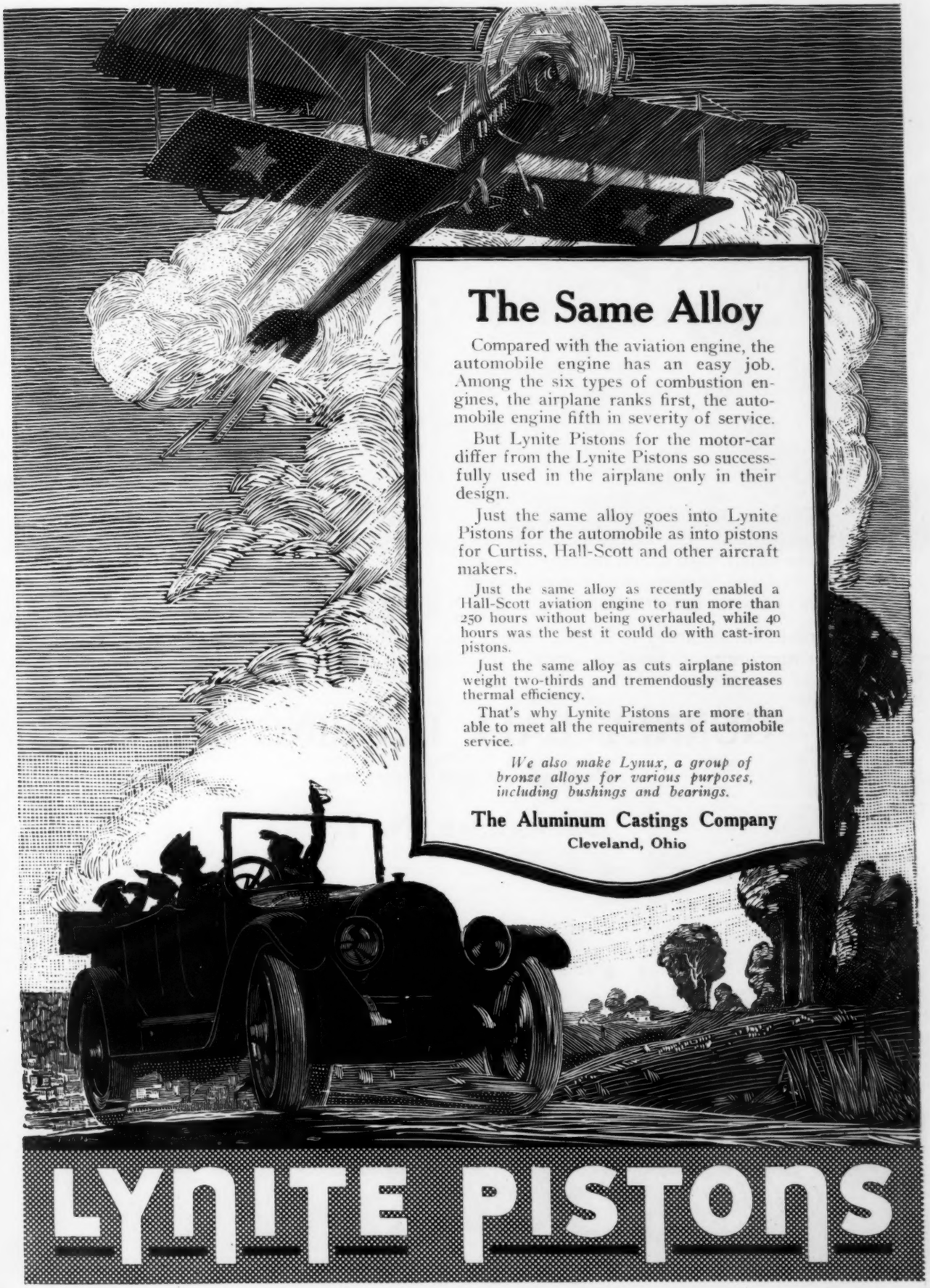
That is why it is ultimately adapted for service where other steels fail.

That is why we urge all manufacturers of locomotives, automobiles or machine tools to specify Vanadium Steel where there is any question as to the best steel.

You can depend upon it, where the problem is Maximum Strength with Minimum Weight that Vanadium Steel is the best solution.

AMERICAN VANADIUM COMPANY

NEW YORK PITTSBURGH LONDON


The Same Alloy
Compared with the aviation engine, the automobile engine has an easy job. Among the six types of combustion engines, the airplane ranks first, the automobile engine fifth in severity of service.
But Lynite Pistons for the motor-car differ from the Lynite Pistons so successfully used in the airplane only in their design.
Just the same alloy goes into Lynite Pistons for the automobile as into pistons for Curtiss, Hall-Scott and other aircraft makers.
Just the same alloy as recently enabled a Hall-Scott aviation engine to run more than 250 hours without being overhauled, while 40 hours was the best it could do with cast-iron pistons.
Just the same alloy as cuts airplane piston weight two-thirds and tremendously increases thermal efficiency.
That's why Lynite Pistons are more than able to meet all the requirements of automobile service.
We also make Lynux, a group of bronze alloys for various purposes, including bushings and bearings.
The Aluminum Castings Company
Cleveland, Ohio
LYNITE PISTONS

This Gurney Ball Bearing will carry 32 Tons

THE bearing illustrated here, while it is not by any means the largest ball bearing ever built, has a rated load capacity of 64,500 lbs. at 140 R. P. M.

A number of these large Gurney Bearings have been in successful operation for some time.

The present field of Gurney usefulness ranges from the carrying of such loads as 32 tons at comparatively slow speeds down to the carrying of a small grinding wheel at a speed of 40,000 R.P.M.

Every Gurney Bearing must measure up to a standard of perfection in which a variation of a few ten thousandths of an inch would be serious enough to cause the rejection of the bearing. For the small high speed bearing this degree of accuracy is necessary to prevent vibration. For the large bearing, which must carry enormous loads, accuracy is necessary to make each ball carry its share of the load, so that no ball will be overloaded.

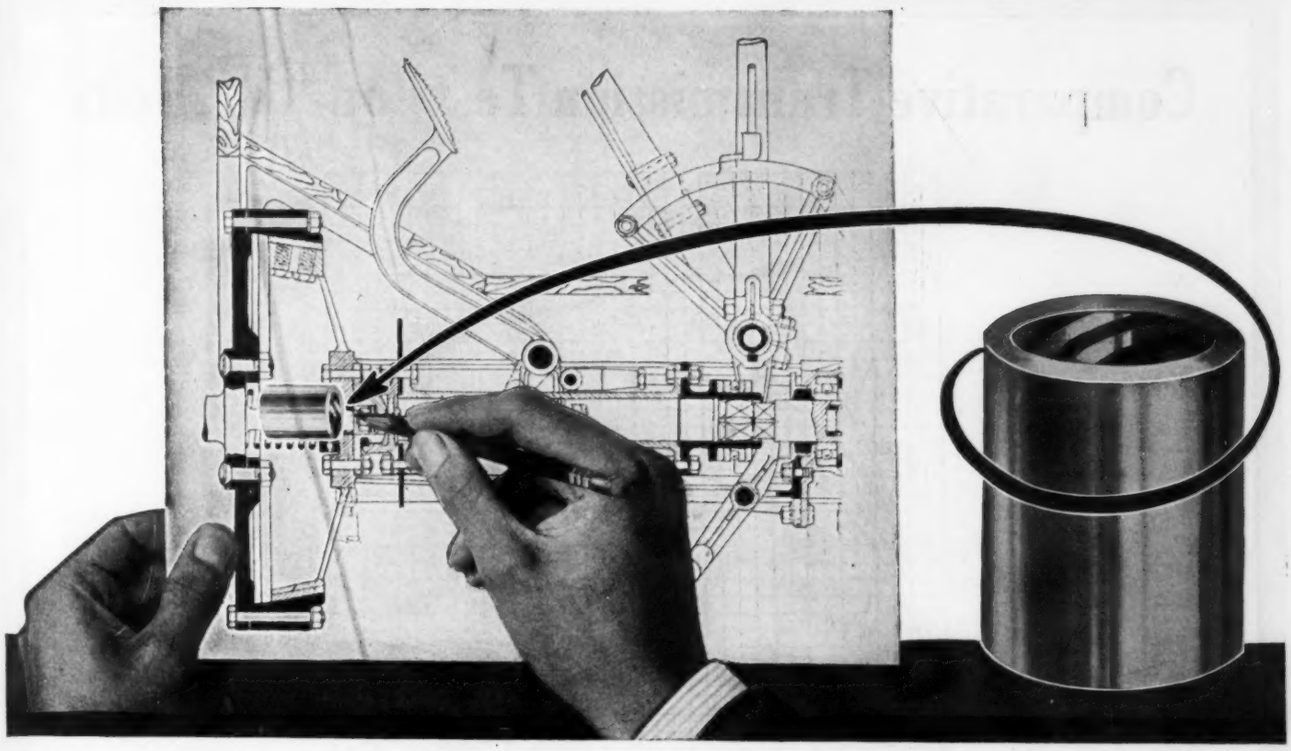
This wonderful accuracy is largely responsible for the widespread use of Gurney Bearings wherever a maximum of bearing service is demanded.

GURNEY BALL BEARING CO.

Conrad Patent Licensee

Jamestown, N. Y.

102



In The Clutch

The Pilot Bushing

One of the most used bushings on a car, and one of the most difficult for the driver to oil and attend to properly, is the Pilot or Thimble Bushing in the Clutch.

Many types of bearings in this situation become dry, get clogged with dust and dirt, wear quickly, and the result is a sticking and bad acting clutch. Many engine builders are asked to drill the shaft to feed lubrication at this point.

Inasmuch as the Clutch is the very gateway through which power is transmitted to the car, and as it is in constant use by the driver, the ease or difficulty of its manipulation is of vital importance.

Leading manufacturers now know from experience and performance that the most logical type of bushing to use in this out-of-the-way, difficult-to-oil place, is a BOUND BROOK OIL-LESS BUSHING.

It's a simple, practical solution of a problem that has been the cause of much annoyance and expense to many car and truck owners.

These bushings protect the inaccessible parts of a car against neglect,—insufficient lubrication. With or without oiling, they give perfect, smooth-running service. Neglect cannot hurt them, for they contain within themselves sufficient lubricant to last their life-time.

Many companies use them as Pilot bushings without in any way changing the original housing. One company has used over a quarter of a million without a single complaint.

We also manufacture NIGRUM (Impregnated Wood) Oil-less Bushings.

All Genuine Graphited Oil-less Bushings have always been made at Bound Brook, U. S. A.

BOUND BROOK OIL-LESS BEARING COMPANY

Specialists in the manufacture of Oil-less Bushings for more than a third of a century

BOUND BROOK, NEW JERSEY

READ WHAT LEADING CAR MANUFACTURERS SAY

"I have no record of this part having been replaced in a single instance."

"Your Bound Brook Graphite filled bearing has worked out very satisfactorily for flywheel end of clutch shaft. We would not think of going back to the old type bearing at this point, for the simple reason it would be practically impossible to properly lubricate this bearing at this point."

"We have had no complaints along this line, as we did when using the other type of bearing at this point."

"We tested a number of these bearings for many months in very hard service, before we decided to adopt them. Nothing in the world would prompt us to change from the bearing we originally used to your self-lubricating bearing except service."

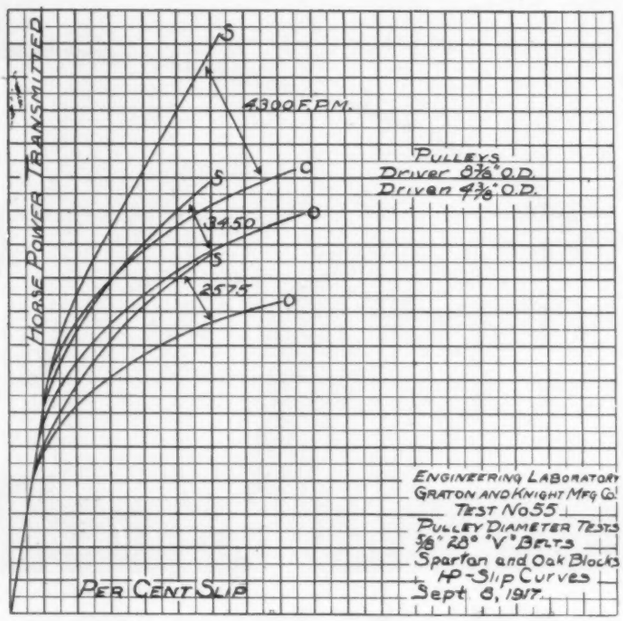
"These bushings are proving entirely satisfactory to us. I really do not know of any occasion where we have had trouble with the bearings. You know how many cars we have put out with your graphited bushings used at this point." (This company has used over a quarter of a million of this type of bushing.)

BOUND BROOK

TRADE MARK REG. U. S. PATENT OFFICE

Oil-less Bushings

Comparative Transmission Tests on "V" Belts



Showing relative values of "V" Belts made from Spartan and Oak Tanned Leather

The above curves show the relative efficiencies of "V" Belts made from Spartan Leather as compared with those manufactured from Oak Tanned Leather. They demonstrate the fact that Spartan Leather is by far best suited for transmission purposes. Spartan "V" Belts guarantee a higher maintained speed of driven pulley, less slippage and longer life.

Spartan Leather by reason of its special tannage and unusual pliability insures a wonderful pulley grip and consequently transmits a maximum amount of power. Furthermore, Spartan Leather withstands effects of oil, water and other injurious agencies always encountered on Automobile, Truck and Tractor Fan Drives.

G. & K. Spartan "V" Belts are especially constructed for Fan, Pump and Generator Drives on Automobiles, Trucks and Tractors. They are grouped in two different classes:

Spartan Solid Type "V" Belt
Spartan Block Type "V" Belt

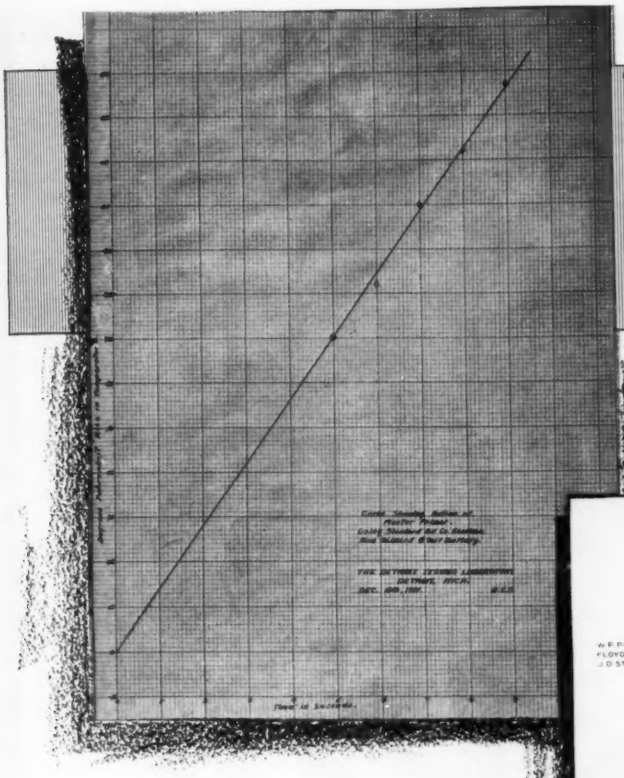
The requirements of each individual drive determine the most suitable type.

Our engineers will be glad to offer recommendations or lay out drives to meet your particular requirements.

THE GRATON & KNIGHT MFG. CO.

Worcester, Mass.

Branches in all Principal Cities



Figures on the left of above chart show degrees Fahrenheit rise in temperature. Figures at bottom show time in seconds. Standard Oil Company gasoline and Willard 6-volt Battery were used in making this test.

The Detroit Testing Laboratory

ANALYTICAL CONSULTING AND RESEARCH CHEMISTS
INDUSTRIAL CHEMICAL RESEARCH A SPECIALTY

W. P. PUTNAM, President
FLOYD W. ROBISON, V. Pres
J. D. STODDARD, Sec'y-Treas

ASSOCIATES
THE TORONTO TESTING LABORATORY
G. WALBEE, Mining Engineer

674 WOODWARD AVENUE

DETROIT, MICH.

December 6th, 1917.

Master Primer Company,
1523 West Fort Street.
Detroit, Michigan.

- Attention of Mr. E. T. Daniels.-

Gentlemen:

We have the following report to make on the experiment which we conducted for you on one of your primers. The primer was connected up in the laboratory with a 6 Volt, Willard storage battery and in the same manner in which it is connected up in the car. We found that the temperature of the Gasoline in the primer was raised at the rate of 14° per second, indicating that in ordinary winter weather the primer would start an engine in from one to four seconds.

Trusting that this is the information that you desire, we are,

Very truly yours,

THE DETROIT TESTING LABORATORY.

D C Stewart

To Summarize—

The chart and letter which appear here show that by raising the temperature 14 degrees per second the Master Primer will start a motor within from three to five seconds in zero weather.

And while generating this heat the Master Primer draws less than twenty amperes. It uses about as much electricity as the horn.

It saves the battery because the immediate starting of the motor prevents the long spinning that otherwise is necessary in cold weather.

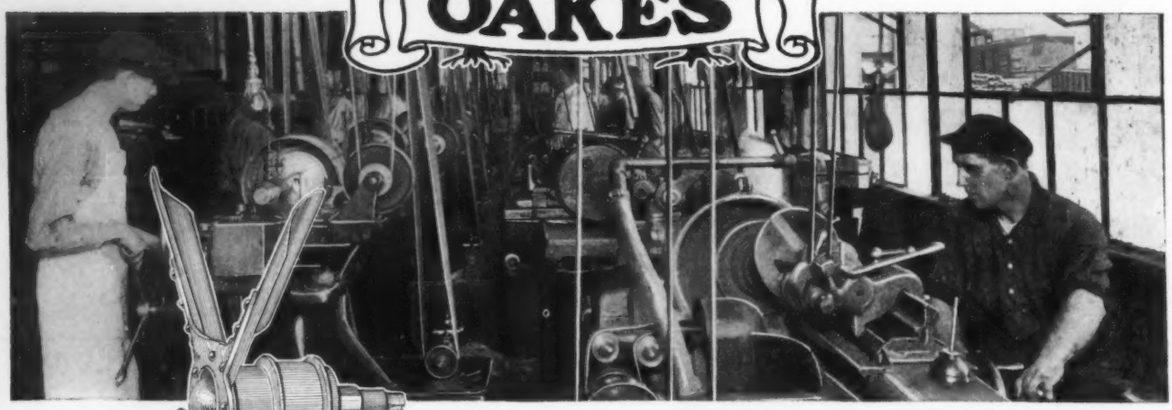
Write today for blue prints and detailed information of the Master Primer. No cost—no obligation.

MASTER PRIMER COMPANY
1522 Fort Street W Detroit, Michigan

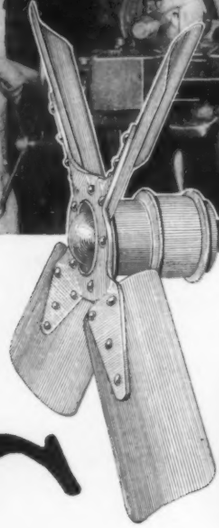
Master ELECTRICAL Primer

Instantaneous Starting in Zero Weather

OAKES



View showing corner of the grinding department in the largest factory in the world devoted exclusively to the making of cooling fans.



Oakes Cooling Fans

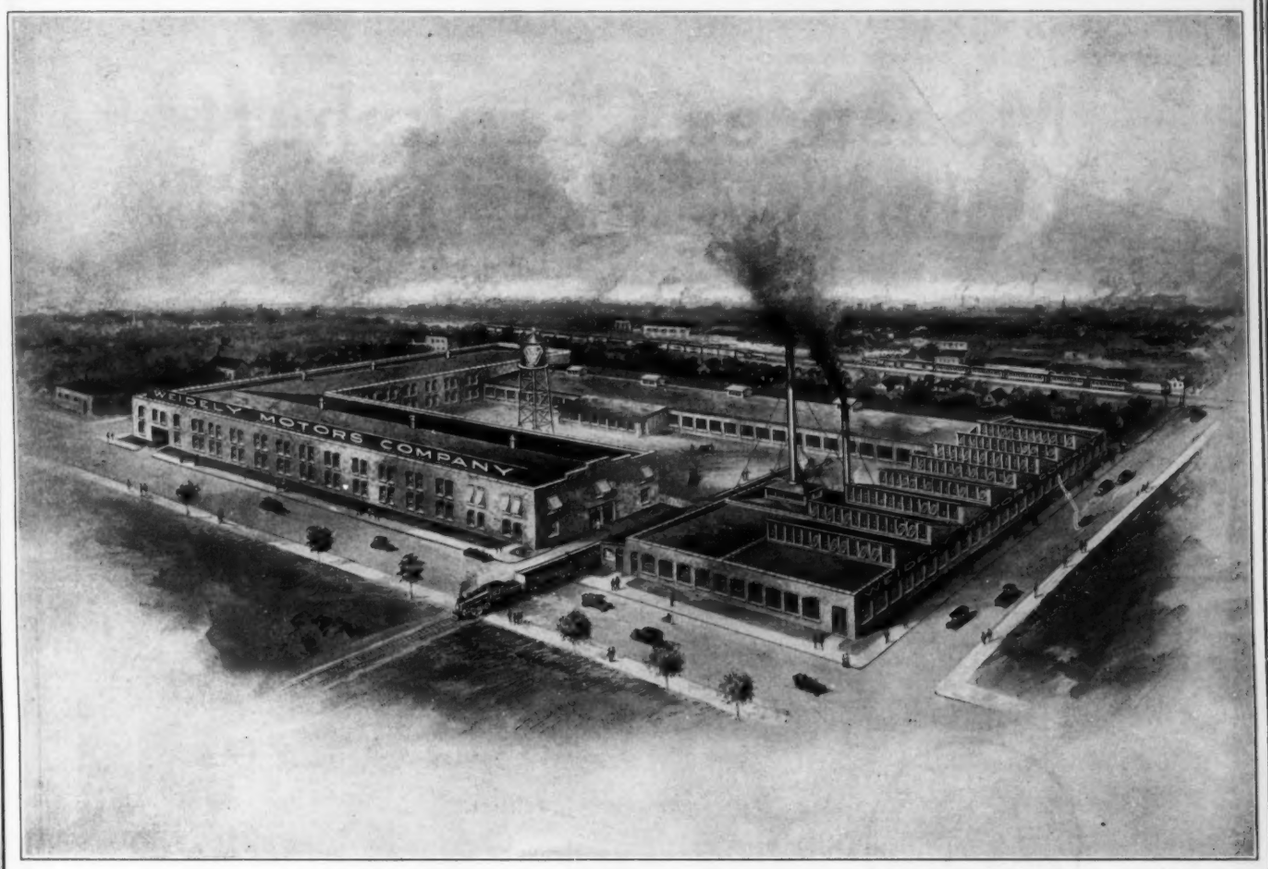
THE OAKES Curved Type Cooling Fan, shown above, was designed by Oakes engineers, and is recommended especially for use when efficient cooling depends on the volume of air delivered from the fan.

Oakes Fans give the maximum amount of cooling with the minimum amount of horsepower.

There have been over 175 pleasure car, truck and tractor manufacturers adopt this improved type of fan.

The Oakes Company

Indianapolis **U. S. A.**



85,000 FEET OF FLOOR SPACE DEVOTED ENTIRELY TO THE MANUFACTURE OF MOTORS

The Weidely Motors Company, when experience is considered, is probably the oldest firm making motor-building a specialty. All details of manufacture are under the direct supervision of G. A. Weidely, who, with the present organization, has been engaged in designing and building motors and automobiles for sixteen years, and the success of the "Weidely" Valve-In-Head Motors is the result of this experience.

THREE MODELS — FOUR SIZES

Model C 12 Cylinders $2\frac{7}{8}$" Bore x 5" Stroke
Model M 4 Cylinders $3\frac{1}{2}$" Bore x $5\frac{1}{2}$" Stroke
Model M 4 Cylinders $3\frac{3}{4}$" Bore x $5\frac{1}{2}$" Stroke
Model RM 6 Cylinders 4" Bore x $5\frac{1}{2}$" Stroke

Simple—Accessible—Reliable

Weidely Valve-In-Head Motors have earned an enviable reputation and are fully guaranteed.

WEIDELY MOTORS COMPANY

INDIANAPOLIS, INDIANA, U. S. A.

Measures Crankshaft Unbalance in 5 Minutes

By using the Carwen Dynamic Balancing Machine, the balancing of airplane crankshafts becomes an exact science.

For the former tedious process of cut-and-try it substitutes the rapid manipulation of two adjusting-wheels, resulting in a definite measurement of the moment of unbalance.

A chart converts the machine's reading into amount of metal to be removed at two (sometimes three) selected points.

That metal is removed by an ordinary drill press hand, reading from a tag.

The entire process of

(1) balancing on centres,

(2) measuring dynamic unbalance by the Carwen Machine,

(3) converting the Carwen machine's reading by chart,

(4) drilling the holes,

takes only twenty minutes. The result is more accurate than by any method of trial and error.

We will gladly demonstrate. Booklet on request.

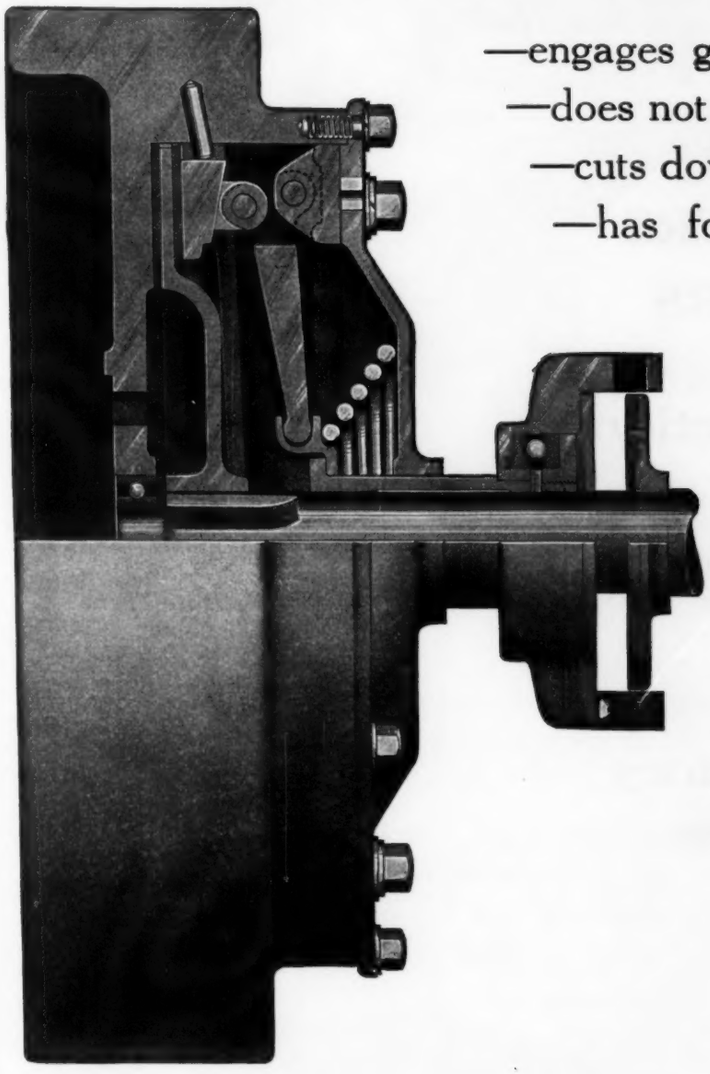
THE CARLSON-WENSTROM CO.
Erie Ave. at Richmond St.
Philadelphia, Pa.

Makers also of Carwen Ball Bearings

CARWEN
Dynamic Balancing Machine
(AKIMOFF PATENTS)

BORG & BECK

Single Plate Dry Clutch



—engages gradually
—does not grab, stutter or slip
—cuts down gear shifting
—has fool-proof adjustment

The *merits* of this clutch have made it standard in the *truck, tractor* and *automobile* industry—over 200,000 now in use—by over 150 leading manufacturers.

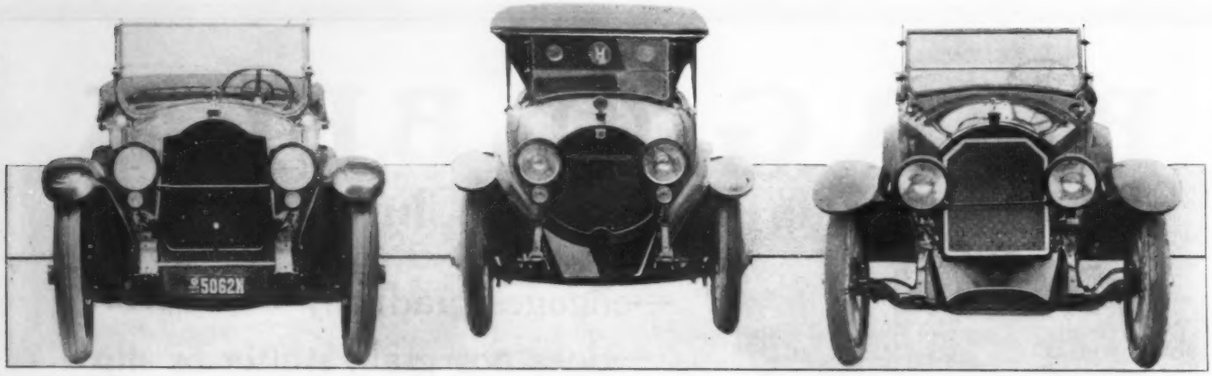
Furnished to fit all standard motors and unit power transmissions.

THE BORG & BECK COMPANY

MOLINE, ILL.

Largest exclusive clutch manufacturers

BORG & BECK MOLINE, ILL.



SILENT PARTNERS OF THE MOTORS

33 Cars of Distinction Rely Upon Them

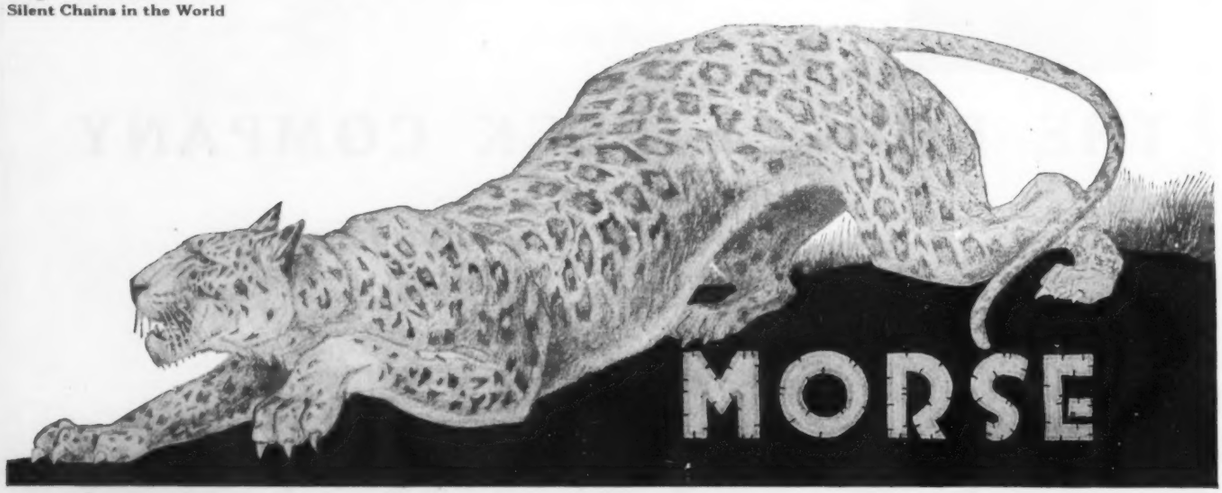
Visit the MORSE Booth
(C-42)
At The New York Show
And Become Acquainted with

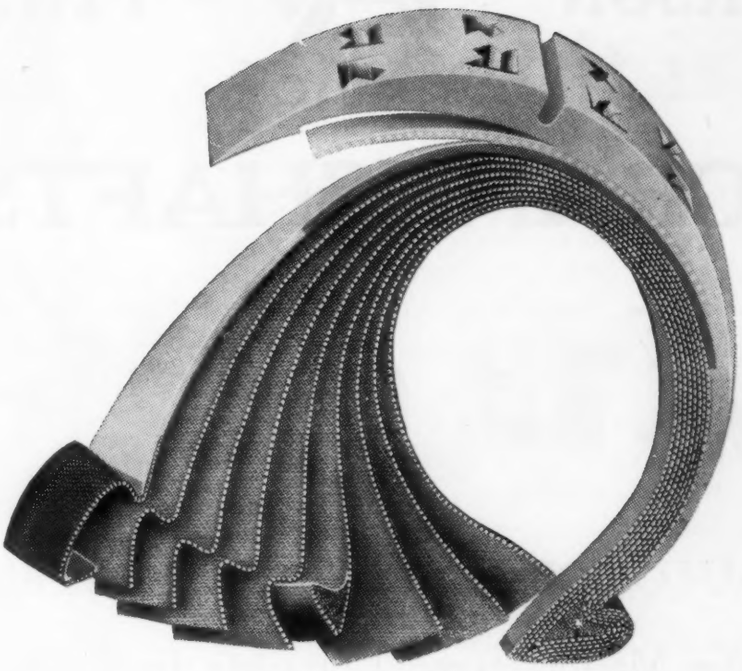
The Most Satisfactory of Front End Drives

MORSE SILENT CHAIN FRONT ENDS

Investigate Them at the Show

MORSE CHAIN CO., Ithaca, N. Y.
Largest Manufacturers of Silent Chains in the World





The strength of a tire is in the carcass.

The strength of the carcass is in the number of plies of fabric.

The number of plies for a given tire cross section can be the maximum which will run without meshing under the load, or the minimum which will theoretically carry the load.

HOOD TIRES use the maximum.

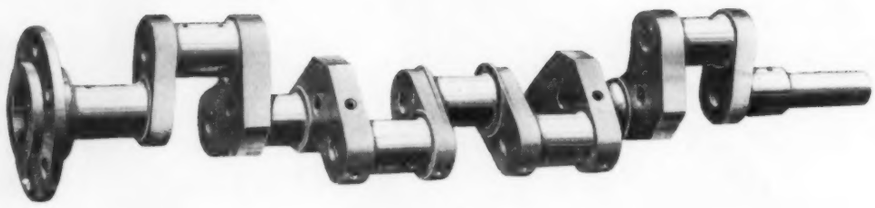
HOOD users buy again and again.

Count the plies and compare with standard oversizes and you have the "why" of the "extra ply."

HOOD TIRE COMPANY, Inc.
WATERTOWN, MASS.

ANDERSON QUALITY SERVICE TRADE MARK FINISHED

CRANKSHAFTS



FOR AUTOMOBILE AND AIRPLANE MOTORS

Are Manufactured Complete from Raw Material to Finished Product in Our Well Equipped Forge and Machine Shops

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The Packard Twin Six Crankshaft Illustrated Above was Forged and Machined in Our Factory

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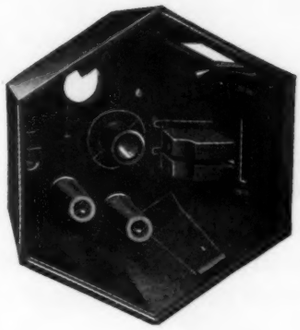
Anderson Crankshafts and other Anderson Drop Hammer and Upset Forgings which will be on Exhibition at the New York and Chicago Automobile Shows will demonstrate our ability to solve your Crankshaft and Forging Problems

Send us your inquiries

Anderson Forge & Machine Co.

Detroit, Michigan



Condensite
—what it is

Condensite is a substance that has made plastic molding a machine process of general application. It is a product of synthetic chemistry, and is made of phenol (carbolic acid) and formaldehyde, and its scientific name is "Phenolic condensation product;" this product is the pioneer in America of synthetic chemistry.

When heated, Condensite softens to such an extent that it may be readily molded under pressure into any desired form. The further application of heat then hardens it permanently so that it will not again soften under heat. It is in this final permanently hard form that Condensite is best known.

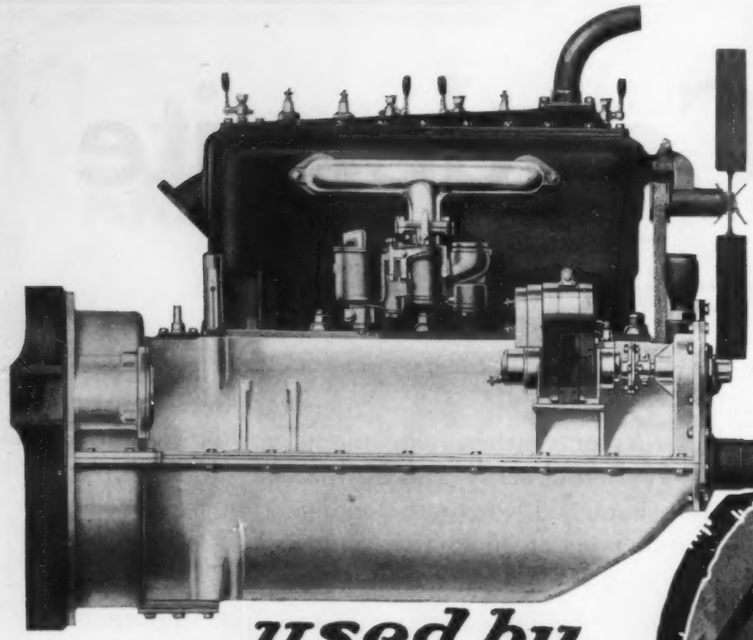
It is insoluble in oils, acids, and, in fact, all solvents except alkaline.

Condensite has great mechanical strength in tension, compression and shear, has extremely high dielectric resistance, is very hard, retaining its finish and color indefinitely, is unaffected by temperatures below the carbonization point, and is odorless. It is readily machined, filed, sawed and takes a high, lasting polish when buffed.

We are prepared to advise whether Condensite can be adapted to your uses, and for that purpose maintain an efficient research organization. We will direct its energies to the solution of your problem if you will give us the requisite information for our guidance; a drawing of the part, a description of its functions and the conditions surrounding its use, i.e., the mechanical or electrical stresses to which it is subjected, the temperature if unusual, to what chemical action, if any, it is exposed; and the approximate quantities required.

Condensite Company of America
Bloomfield, New Jersey

2003



WISCONSIN CONSISTENT MOTORS

used by UNITED MOTOR TRUCK COMPANY

Wisconsin Motors were chosen by the United Motor Truck Company—chosen because with the selection of a power plant came the realization that its qualities must be in keeping with the demands made on their trucks—heavy loads, the wear and grief of hard usage—the rack and strain of bad roads—a motor that will give constant service—rain or shine, summer or winter, and do it at a moderate cost.

Consistent, reliable performance in every field of motordom has earned an enviable reputation for

Wisconsin CONSISTENT **Motors**

Years of struggle—and the pride of accomplishment—stand back of that reputation.

Motor experts, second to none, studied the difficulties of truck requirements and gradually adopted the principles of proven worth and discarded those of doubtful utility.

The reward—a motor whose every part attests its capability—whose every new achievement but adds to a long list of previous successes.

WISCONSIN Motors for pleasure cars, tractors and trucks—all four-cycle—are made in four and six cylinders.

Write for catalog of specifications.

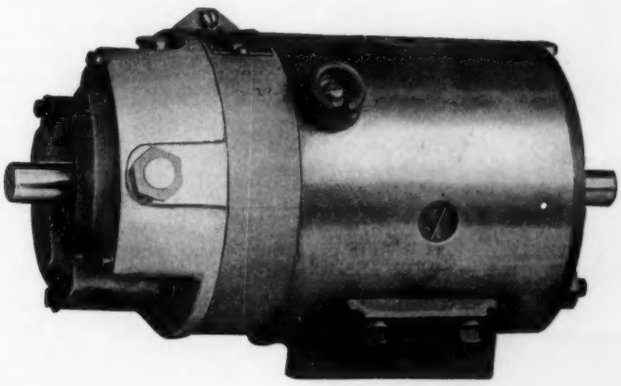
WISCONSIN MOTOR MFG. COMPANY

Sta. A, Dept. 318 **MILWAUKEE, WISCONSIN**

Westinghouse

STARTING, LIGHTING & IGNITION EQUIPMENT

For the Tractor
A Foolproof Generator



W
WESTINGHOUSE ELECTRIC

United States Government "Standard Specifications for Class 'A' and Class 'B' Gasoline Motor Trucks," of May, 1917, state in part as follows:

"*Generators:* The generator shall be of the *fully enclosed*, direct-current, constant-voltage type, with a *flat or drooping voltage characteristic*, and must have a continuous capacity o 12 amperes. The voltage of the generator when installed on the truck shall be not more than 8 volts at one ampere, and not less than 7 volts at 15 amperes. The voltage regulation must be the same with varying engine speeds, up to governed engine speed.

Regulation: All voltage and current-regulating devices shall be contained in assembly with the generator. The use of sliding contact devices for current or voltage regulation, and the use of permanent magnets in the construction of generator is also prohibited.

"*Charging Speed:* The generator shall begin to charge the battery at an engine speed of not more than 500 R.P.M. and at the same time furnish the current necessary for ignition."

These specifications require a generator with very close voltage regulation, and one that will regulate properly even if the battery is disconnected.

The Westinghouse Generator for motor trucks has been specially designed to meet these strict specifications. It not only meets them but in some features goes beyond what is actually required.

Westinghouse Electric & Mfg. Co., AUTOMOBILE EQUIPMENT DEPARTMENT
Shadyside Works: East Liberty P. O. Station, Pittsburgh, Pa.

For
TRACTOR SERVICE
G & O
Radiators
fill the demand for an engine cooling unit of proven reliability; the result of correct design, painstaking attention to the details of manufacture and the use of the very best materials.
Our Engineering Department is at your service
The G & O Mfg. Co.
New Haven, Conn., U. S. A.
G&O
Radiators

BOOK REVIEWS—Continued

subjects between members of our expeditionary forces and our non-English speaking allies.

The glossary has been divided into four main divisions: Flying Field Terms, The Plane, The Engine, and Tools and Shop Terms. These are given in both the English-French and the French-English equivalents.

Illustrations have been incorporated in the glossary, the names of the different parts being marked in both English and French. These cover all important parts of the airplane; sectional views of the Hall-Scott aviation engine are also presented.

THE PRINCIPLES OF IRON FOUNDING, by Richard Moldenke. Published 1917 by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York. Cloth, 6 by 9 in., 516 pages, 39 ill. Price, $4.

It is the author's opinion that this work should not be considered in any sense a handbook, but more of a study upon which handbooks can be built. The book does not contain illustrations of obsolete cupolas or of carbon diagrams interesting but useless to the foundrymen; but it does go into the elements of iron-making with its allied industries with the object of drawing conclusions of value to the foundryman.

The work has been divided into ten main divisions, these dealing with the history, the industrial status, and the organization of the foundry; outlines of iron metallurgy and iron-making processes; the properties of cast iron, classification of castings, foundry raw materials, and the technology of combustion and melting processes.

The chapter on the history of iron founding traces the practices from the bronze age up to the first recorded example of pig iron found in Siegerland of Westphalia in 1311 A. D. and on up to the present time.

The author states that modern foundry advances, which have brought about a revolution in the industry, have practically occurred in the last twenty years of the nineteenth century. These advances took place simultaneously and almost independently in the United States, Germany, and Great Britain.

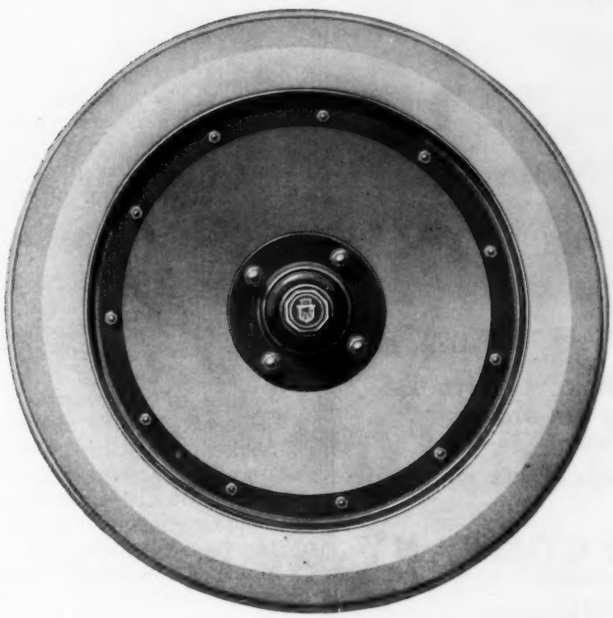
The outline of iron metallurgy is presented more from the viewpoint of the foundrymen than of the metallurgist. The effect of carbon, silicon, manganese, sulphur, phosphorous, oxygen, and other elements when combined with iron are given. The descriptions of different iron-making processes, such as the direct wrought-iron process, the blast furnace, the indirect wrought-iron process, the puddling process, mechanical puddling; conversion processes, such as cementation, crucible, Bessemer and open-hearth, are presented in full.

The main properties of cast iron, such as fusibility, fluidity, thermophysics, grain structure, porosity, specific gravity, chill, hardness, shrinkage, segregation, strength, and electrical properties, are taken up separately and discussed.

General data are given on a great variety of castings. Foundry raw materials are given an extensive treatment, over 100 pages being devoted to descriptions and specifications of metals, fuels, fluxes, refractories, fans, and smaller supplies.

The technology of combustion is given in detail, special emphasis being put on analysis of flue gases, as in the author's estimate this is the best means of ascertaining whether the combustion attained is of a high degree of efficiency for the fuel involved. Melting processes are described fully, illustrations being given of different

(*Concluded on page* 44)



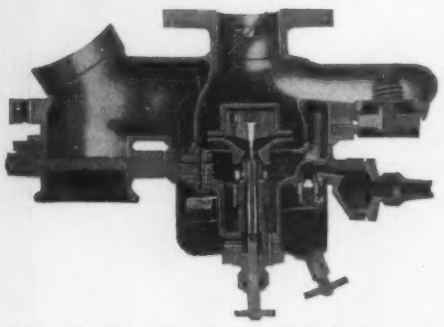
Disteel Wheels

Disteel Wheel equipment is infinitely more in harmony with the sweeping lines and plane surfaces that are characteristic of the smartest passenger cars, besides making possible more pleasing color effects in finishing. Not the least of the functions of Disteel Wheels is that of concealing brake rods, springs and other under-body equipment, unsightly enough in itself and almost impossible to keep clean. Careful consideration of the accompanying illustration will make clearer the distinctiveness and harmony of Disteel-equipped cars.

DETROIT PRESSED STEEL COMPANY

1816 Mt. Elliot Avenue, DETROIT, U. S. A.

SHAKESPEARE CARBURETORS



Standard Top Outlet Model (Sectional)

CARBURETOR AIR ("CHOKE") CONTROLS
CARBURETOR HOT AIR STOVES

Blueprints, Literature, Samples, Prices on request

SHAKESPEARE COMPANY
(Carburetor Division)
Kalamazoo, Michigan
DETROIT, 811 Woodward Ave.

Tires that are kept inflated to the pressure recommended by tire makers last twice as long as tires that are used with the air in them unmeasured.

Use a SCHRADER
UNIVERSAL TIRE PRESSURE GAUGE
and double the life of your tires.
Price in U. S. A. one dollar and twenty-five cents, at your dealer or

A. SCHRADER'S SON, Inc.
783-803 Atlantic Ave Brooklyn
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Highest award at the Panama Pacific Exposition

For Tire Life

BOOK REVIEWS (Concluded)

types of cupolas. The general sequence of the metal charge is followed from the charging to the pouring. The open-hearth and electric furnace melting processes are mentioned. Standard tests of cast iron are given in a short chapter on testing.

A glossary of foundry terms has been incorporated in the book. The appendix contains standard specifications of gray iron castings, standard methods for sampling and analysis of pig and cast iron and other standard tests and determination methods of interest to the foundryman.

GOVERNMENT PUBLICATIONS

EXTRACTION OF GASOLINE FROM NATURAL GAS BY ABSORPTION METHODS. By George A. Burrell, P. M. Biddison and G. G. Oberfell. Published, 1917, by the Government Printing Office, Washington. Paper, 6 by 9 in., 71 pages, 10 tables, 19 ill. Price 10 cents.

One of the methods of extracting gasoline from natural gas is by absorbing the gasoline in oil and subsequently distilling the resulting mixture and condensing the gasoline vapors in proper receptacles. This method is distinctly different from the compression and condensation method used for a number of years in extracting gasoline from casing-head gas. The absorption method, as the former is known, is fully described in this bulletin of the Bureau of Mines. This Bureau has been, and still is, conducting a series of investigations in the endeavor to ascertain the most efficient method of obtaining gasoline from petroleum and natural gas.

The bulletin takes up briefly the manufacture of gasoline from casing-head gas by the compression and condensation method. The absorption process, which has been developed slowly as the demand for gasoline has increased, is described in detail.

A large experimental plant having a capacity of 15,000 to 30,000 cu. ft. per hour is described. The detail drawings illustrating this apparatus add considerably to the value of the bulletin.

The operation of the absorption gasoline plant is explained thoroughly. Data on the cost and construction of a large-scale plant are given, each piece of apparatus being discussed separately. It is stated that there are great possibilities in the application of this absorption method to casing-head natural gas, much of which is too lean to be treated by compression and condensation methods.

In the Leeds & Northrup Potentiometer System of Pyrometry

precision and sensitivity are combined, the effects of resistance in galvanometers, lead wires and thermo-couples being eliminated.

Inexpensive and readily replaced base metals can be used instead of highly expensive platinum. By making the lead wires of the same metals as the thermocouple, the "cold" junction is brought back to the potentiometer, where its effects are readily compensated for automatically.

Ask for our new Bulletin M. 875.

THE LEEDS & NORTHRUP CO.,
4905 Stenton Avenue PHILADELPHIA, PA.

MORELAND TRUCKS
for U. S. ARMY
Equipped with
Smith Wheels
"EVERLASTING"

YOUR TRUCK or Uncle Sam's—any capacity from One Ton to The Limit—will Run Easier, Last Longer and **DELIVER FAR GREATER MILEAGE** from **TIRES** and **GASOLINE** when equipped with **SMITH WHEELS.**

Moreland have made Smith Wheels standard equipment for their 1½, 2½, 4 and 5-ton models

Smith Wheels guaranteed **FOR LIFE OF TRUCK** on which originally placed

Insist on Smith Wheels every truck you buy!

SMITH WHEEL INC.
SYRACUSE, N.Y. U.S.A.

1816 1917

Frasse-Electric Steel Works, Hartford

Frasse-Electric Steel

High Grade Tool Steels
Alloy Construction Steels
Shafting and Screw Steel
Polished Drill Rods
Heat-Treating, Annealing, Case-Hardening, Cold Drawing, Turning and Polishing

Full information about our works and its products in our new catalogue. Copy mailed on request.

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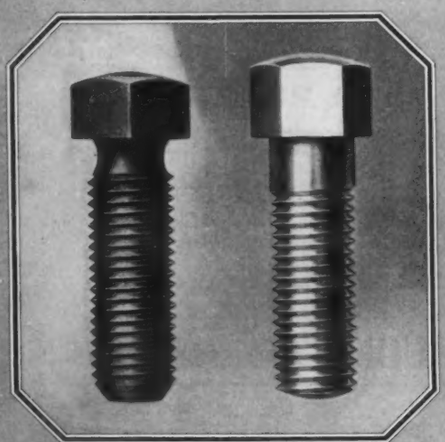
417-421 CANAL STREET NEW YORK CITY
PHILADELPHIA BUFFALO (Works) HARTFORD

1907 CLEVELAND 1917
WROUGHT PRODUCTS



CAP SCREWS STUDS SET SCREWS
SCREW MACHINE PRODUCTS
STEEL STAMPINGS

Let us know your requirements, in order that our modern plants may serve you

The Cleveland Wrought Products Co.
Cleveland, Ohio

Positions & Men Available

The following announcements are published for the information of members of the Society. No charge whatever is made for these announcements. Additional information will be supplied by the office of the Society. When items are prefixed by asterisk, written applications should be sent to S. A. E. office to be forwarded. Applications from non-members for positions must be properly endorsed by a member of the Society.

Positions Available

GOVERNMENT POSITIONS. A number of positions in the Government service are open in commissioned, enlisted and civilian capacities. This personnel work for the Society is being handled entirely by the Washington Office, 337 Munsey Building, Washington, D. C.

408. DESIGNER, experienced on commercial motor vehicles. Answer by letter, stating age, nationality, experience, etc. Location, Long Island City, N. Y.

427. ELECTRICIAN, capable of taking complete charge of work for car manufacturer. Must understand wiring of bodies and be experienced in ignition and electrical equipment for gasoline cars. Location, South Carolina.

434. HIGH-GRADE BODY, TOOL AND JIG DESIGNERS. Men capable of organizing and taking charge of departments later on. Permanent positions to right parties. Give references, experience and salary expected. Location, Minnesota.

445. EXPERIENCED AUTOMOBILE DESIGNER. Full statement of qualifications, salary expected and references must accompany application. Location, Indiana.

446. GENERAL FACTORY MANAGER, one capable of handling large production and taking charge of all activities in an automobile factory employing 3500 men. State age, experience, present position. Location, Syracuse, N. Y.

449. PRODUCTION MANAGER, capable of issuing orders and keeping records of stock. Must be experienced and immediately available. Salary, $2,500. Location, Ohio.

451. SALES MANAGER wanted by an automobile company with a capacity of 3000 cars per annum. The applicant must have experience in the automobile field and furnish references, salary wanted, etc. Location, South Carolina.

452. MANAGER FOR SERVICE DEPARTMENT by automobile company with capacity of 3000 cars per annum. Must have experience in the automobile field and give references, state salary wanted, and when available. Location, South Carolina.

453. PURCHASING AGENT. Wanted by automobile company with a capacity of 3000 per annum. Applicant must have experience in the automobile field. Furnish references, state salary wanted, etc. Location, South Carolina.

(*Continued on page* 48)

MAGNALITE PISTONS

Sand and Die Cast

The Ultimate Word in Aluminum Alloy Pistons

Used as standard by the most prominent automobile, airplane and speed boat manufacturers

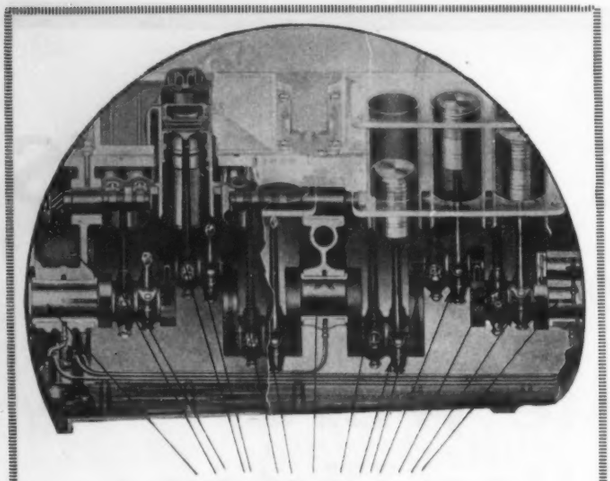
Send for Special Booklet on Piston Design

M'f'g solely by

WALKER M. LEVETT COMPANY

417-419-421 East 23d Street, NEW YORK

The Pioneer Aluminum Alloy Piston Manufacturer



Where Laminated Shims Insure Accuracy of Alignment

Cap bearings adjusted with Laminated Shims *must* be in exact alignment, unless the bearing or journal is inaccurate.

For there is no possibility of the Laminated Shim being other than absolutely smooth, with both faces always parallel.

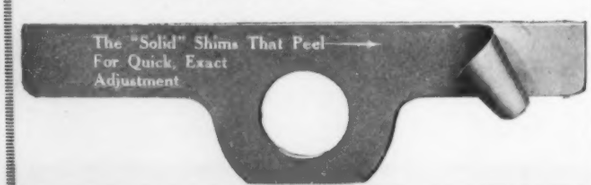
The two shims for the opposite sides of the bearing, moreover, can be made exactly alike in thickness.

That means that the cap *must* be parallel to the pedestal and the journal *must fit* over its entire length.

Many manufacturers are using Laminated Shims for cap bearings, because of the accurate alignment which they insure—even more than for the saving of time in assembling.

Laminated Shims will give you better, quicker results in your split bearings. Write for a sample shim—That will prove it.

Laminated Shim Co.
533 Canal Street, New York City
1216 Dime Bank Bldg., Detroit, Mich.
Weiss-Bosley Company, St. Louis, Mo.



POSITIONS & MEN AVAILABLE *Cont.*

Positions Available (Continued)

454. HIGH-GRADE DRAFTSMAN, who has had experience in detailing and designing a 6-cylinder valve-in-the-head engine. Write fully, giving in detail experience and salary.

457. PRODUCTION ENGINEER. For large gear plant in Ohio. Technical man preferred. Must have a thorough theoretical as well as a practical knowledge of gears and their quantity production, together with a wide experience in same. Ability to design special machines to increase production together with forge shop and heat-treating experience are essential. An exceptional opportunity for the right man. Do not answer unless you have the above qualifications. Location, Cleveland.

461. PUBLICITY MAN, with experience, ability, imagination and ambition, is wanted in an automobile concern. One who is familiar with trade-paper and general advertising, catalogs, booklets, folders, printing, photography and illustrations. One whose mind is alert and resourceful, and can turn to advantage in his work items of apparently trivial interest in the day's news of the industry. One who can prepare news articles of such quality that editors will be eager to use them. One who has a college education or its equivalent in sound knowledge, and who would place high value upon the opportunity of associating himself with the most conservative and one of the oldest manufacturers of automobiles in the industry which is just now about to exploit its fundamentally superior product in terms of modern merchandising. One who would find the joy of achievement in such an enterprise, and even greater satisfaction than the pecuniary reward, which would be ample. Location, New England.

462. SALES ENGINEER, by large pressed steel manufacturers. High-grade man wanted with both technical and selling experience. Excellent opportunity. Location, Indiana.

463. TOOL AND DIE DESIGNER. Several vacancies on aeroplane construction work for high-grade, experienced designers of tools, jigs, fixtures and dies. Excellent opportunity for advancement. Location, Buffalo.

464. ASSISTANT FOREMAN, with sufficient experience on Clevelands and Gridleys for position in Automatic Department. The opportunity offered is exceptional for the young man who considers his future. Location, Pennsylvania.

466. DETAILERS AND LAYOUT MAN for work on railway motor cars. Experience in gasoline and kerosene engine design is desirable. State experience and salary expected in first communication. Location, Michigan.

467. MANUFACTURERS' AGENTS or sales representatives desired by manufacturer with main office in New York. Men wanted who would handle products exclusively or as a side line on commission basis. The lines manufactured include factory equipment and mechanical specialties, as well as patented electrical devices and standard fittings.

469. BODY DRAFTSMAN, young man with good taste and with experience in the best shops, who can

(*Continued on page* 50)

Simplifying Manufacture

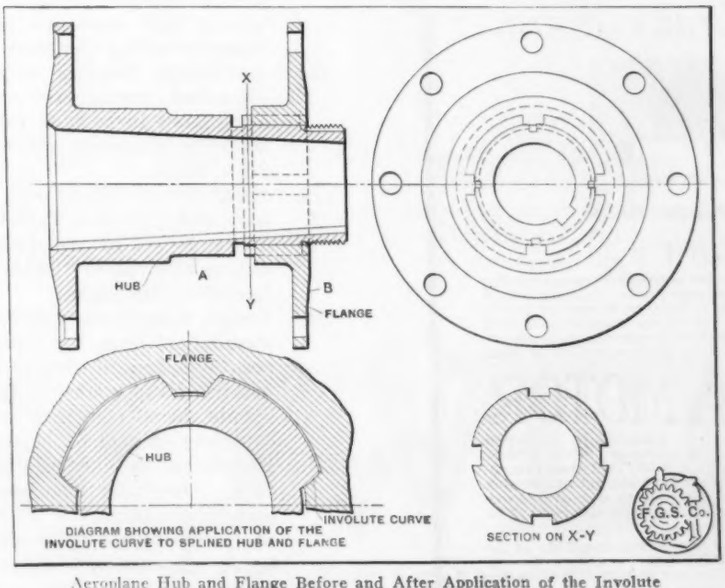
The progressive engineer, designer, superintendent or works manager is always interested in methods which simplify manufacture. He can thereby not only reduce manufacturing costs, but in many cases can turn out a superior product.

The illustration presented herewith shows a propeller hub and flange for an aeroplane. In some cases the projections or keys in the flange have been produced by broaching, and the mating key-slots in the hubs by milling.

This necessitates two distinct machining operations, employing different types of machines and cutting tools—broaching for the flange and milling for the hub.

But what is of still greater importance is the fact that when these parts are made in many different plants trouble is generally experienced in assembling unless exceptional care is taken to have every manufacturer work to extremely close tolerances.

BY THE GEAR SHAPER METHOD the **splines** of both members are **generated** by the **Gear Shaper Cutter,** doing away entirely with the **inaccuracies** which inevitably result when the milling and broaching methods are used, and at the same time greatly facilitating interchangeability and decreasing manufacturing costs.



Aeroplane Hub and Flange Before and After Application of the Involute Curve to the Splined Portion.

This is one of the many problems touched upon in our new booklet, "Design of Splines and Clutch Teeth," a copy of which will be sent upon request.

YOUR CORRESPONDENCE IS SOLICITED.

The Fellows Gear Shaper Co.

Springfield, Vermont, U. S. A.

TEXACO

Texaco Motor Oils

A grade for every type of motor. They have the right body to withstand high heat. They flow and lubricate below zero. Texaco Motor Oils do not leave hard carbon deposits.

Texaco Thuban Compound

for Transmissions and Differentials

With this lubricant fill the gear case *only up to the lowest gear tooth*. One such filling will last for 5000 to 10,000 miles. Each gear tooth is coated. There is less noise, less wear. Thuban sticks, lasts longer, lubricates better.

Texaco Motor Cup Grease

An unusually efficient and economical lubricant in the grease cups of any car.

Write for particulars.

There is a Texaco Lubricant for Every Purpose

THE TEXAS COMPANY

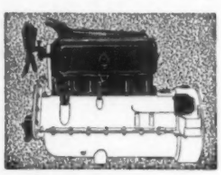
17 Battery Place, New York City

HOUSTON CHICAGO

NEW YORK

Offices in Principal Cities

"LET US HAVE THE FACTS"—No. 7



TESTS

"Quantity production" always seriously threatens quality; for it is based on the effort to *meet a price*. It cannot allow for tests thorough enough to *really prove* that the quality aimed at in the construction of the motor has actually been attained. Until such *real tests* have been successfully passed, any motor is of problematical value *regardless of price*.

The BUDA MOTOR

has its performance assured by a system of inspection and tests unequalled, as far as we know, in the field of commercial motors. *Every* BUDA MOTOR must pass individual part tests, partial assembly tests, entire assembly (belt and then power) tests, after which *it is entirely dismantled* and readjusted. It is then reassembled and given a conclusive dynamometer test.

You are assured to the limit of practical possibility of the full rated power and perfect running condition of every BUDA MOTOR which leaves our factory. This *means something to you* when the motor is "put on the job."

THE BUDA COMPANY, HARVEY (Chicago Suburb) ILL.

POSITIONS & MEN AVAILABLE *Cont.*

Positions Available (Continued)

work in close cooperation with the executives and body builders. One who has the ability and ambition to advance rapidly to the position of body designer and engineer. Cars list at $2,500. State experience and qualifications and salary expected. Location, New England.

470. INSPECTORS for engine and crankshaft departments of manufacturer of four, six and eight-cylinder automobile engines. Location, Illinois.

*471. SALESMEN. A large and old-established tool steel manufacturer desires practical salesmen between the ages of twenty-five and thirty-five to act as residential representatives in the territories of East and Middle West. Men desired with experience in the manufacture of tools and their heat treatment. Successful applicants will be given a course at the works situated in New York State in the manufacture of tool steel, hardening and the fundamentals of metallography. Salary will be paid while the course is being taken. Excellent opportunity for those qualified.

*472. SALESMAN, clean-cut and energetic, for the oldest established firm in its line. Must have thorough knowledge and acquaintance with the automobile trade. While mechanical knowledge is not absolutely essential, those having it will receive first consideration. High-grade men only, capable of conducting a branch office. Answer fully, giving past experience, salary expected and when available.

473. CONSTRUCTION ENGINEER, familiar with arranging machine tools in new factory and capable of taking charge of outside excavation, general plant piping and sewerage systems for an electrical manufacturing company. Location, New York.

474. ENGINEER, familiar with production methods by electrical manufacturing company. Must have experience in routing following up material so as to make shipment promises accurate. Location, New York.

475. ENGINEERING GRADUATE, with some experience in tool and jig design and in handling correspondence, to act as assistant production engineer of automobile parts factory employing 350 men. Location, Michigan.

*476. CHIEF ENGINEER, experienced in structural and mechanical lines for automobile tire plant. Successful applicant should have knowledge of automobile tires, machinery and equipment, and should have sufficient executive ability to take complete charge of department. Location, Ohio.

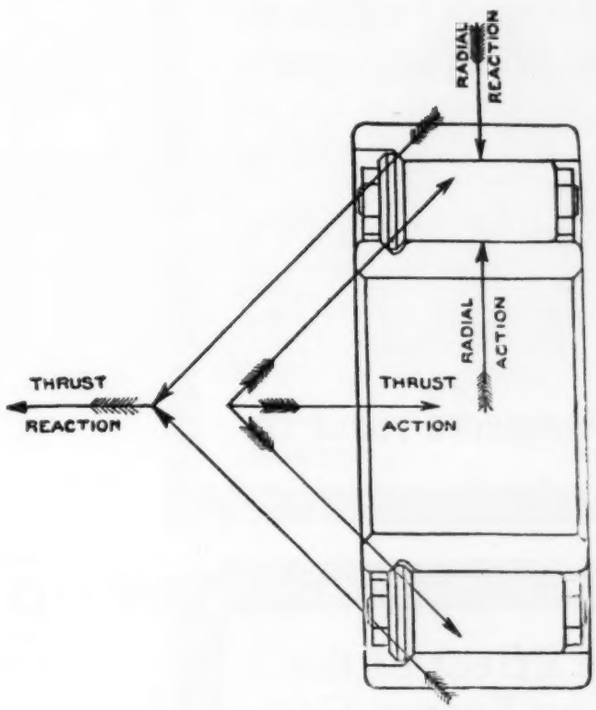
477. ENGINEER, live, energetic, competent on passenger cars. One who has been assistant engineer of plant manufacturing medium or high-grade cars. State experience fully and salary wanted in first letter. Location, Michigan.

479. METALLURGIST, young man familiar with manufacture of electric steel castings and general foundry practice. Must be competent to superintend handling of a small Rennerfelt Electric Furnace in the manufacture of gray iron, semi-steel and steel castings. Plant will be enlarged shortly and work offered represents an opportunity to develop an excellent position. Location, California.

(*Continued on page* 52)

BOWER SAVES POWER

"Bearing Efficiency"



That foremost principle of efficiency, i.e., proper division of labor, is applied correctly only in the Bower Bearing. Two **separate** line surfaces are provided for the two kinds of thrust encountered. The roll supports the constant vertical load; the flange sustains the occasional end thrust. This efficiency of Bower design naturally results in superiority of performance.

BOWER
ROLLER BEARING CO.
Detroit Michigan

JOHN OBENBERGER FORGE CO. BETTER FORGINGS BETTER SERVICE MILWAUKEE WIS PLANT WEST ALLIS

THE MARK THAT STANDS for OBENBERGER SERVICE

Obenberger Forgings Are the Work of Experts

OBENBERGER Forgings are made and handled throughout by experts—specialists whose ability and practice have proved them masters in their line.

Reflected in the guaranteed service of OBENBERGER products is quality of workmanship and material. Orders are receivable for Drop Forgings or Forgings Hammered from Billets by the thousand or 100,000. All perfect.

Write for complete details.

JOHN OBENBERGER FORGE CO.
WEST ALLIS WISCONSIN

The Effect of the War on Future Cars

The wide publicity given wartime improvements in car construction is focusing the public's attention on these accomplishments. The result will be a tendency on the part of car buyers to expect more and more in the cars of the future. Will your new model measure up to popular expectation in every respect? In so far as *permanently* tight joints are concerned it will, if you use

ACCO CORK
REG. U. S. PAT. OFF.

Gaskets and Washers

The material from which they are made was devised especially for gasket purposes. It is composed largely of pure ground cork, and is at once resilient and impervious to liquids. Leakage is therefore impossible.

Specimen Acco Gaskets, cut to your specifications, will be cheerfully furnished without cost.

Armstrong Cork Company
127 Twenty-third St. Pittsburgh, Pa.

POSITIONS & MEN AVAILABLE *Cont.*

Positions Available (Continued)

480. SALES ENGINEER. New York engineering corporation wishes to correspond with the most forceful salesman available, commission basis. The man we want can become a member of the organization. Also a thoroughly efficient young SALESMAN to develop the firm's own clientage.

Men Available

0432. CHIEF ENGINEER, connected with leading concern, desires change. Fourteen years' experience with the best motor car manufacturers on truck and passenger cars.

0435. SALES MANAGER. General factory representative. One of the oldest and most experienced men in the business. Knows most dealers and conditions in all cities from coast to coast. Specialty is developing sales organizations both in factory and among dealers.

0436. PURCHASING AGENT. Several years' experience in buying for large motor truck manufacturing plant. Salary, $3,600.

0438. CHIEF ENGINEER AND RESEARCH EXPERT, with 16 years' practical training in oil and gas engine development work. Broad experience in both the technical and business side of engineering with special aptitude for research work and the perfection of new ideas. Thoroughly competent to handle men and to take charge of the development, design and construction of high-speed gas or oil engines. At present employed.

0439. ENGINEER. Ten years' experience in designing, experimenting and production of passenger cars and trucks. About 20 years' practical and theoretical experience in various iron industries. An economic systematizer, good executive, and has original and practical ideas. Conversant with existing conditions.

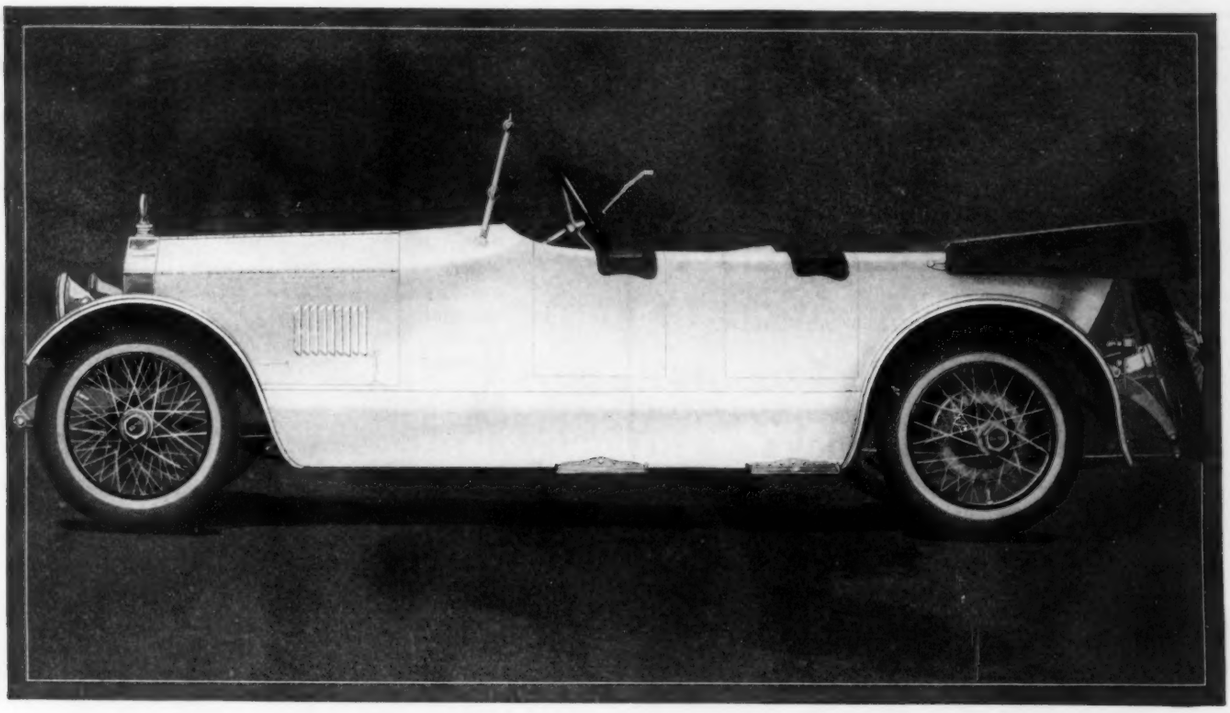
*0440. MECHANICAL ENGINEER, 20 years of wide experience, having both technical and practical training with executive ability, together with broad experience in developing and installation work.

0443. EXECUTIVE of company manufacturing automobiles, electrical engineer and garage manager, desires to devote part of his time to one of these lines of work in New York.

0444. GENERAL MANAGER AND CONSULTING ENGINEER, age 38, American, with long experience and highest standing, is now open for position. Is well known to entire automotive industry.

0446. MECHANICAL ENGINEER, with broad training in the design and production of passenger cars, commercial trucks and gas and steam tractors, desires position with a responsible concern as mechanical engineer, designer or superintendent. Age 37; married. Technical graduate.

(*Continued on page* 54)



Announcement

FOR the 1918 Season, "*Roamer*"—America's Smartest Car—will also be "America's best car mechanically."

The Barley Motor Car Company, manufacturers of the "*Roamer*" car, have contracted for the four and six-cylinder Duesenberg Automobile Motors for the larger cars in their 1918 production.

The manufacturers of the "*Roamer*" car have built up an enviable reputation, they are materially adding to this reputation by installing in their new series the utmost attainable in automobile motors.

Duesenberg Motors Corporation, 120 Broadway, New York City

SERVICE

may be guaranteed by using

KINSLER - BENNETT

TWO-JOINT PROPELLER-SHAFT ASSEMBLIES

Sizes For

1 to 7-Ton Trucks

The quality of K-B products is of the best special drop forge steel throughout. Our interests are your interests. We will gladly help you plan your layouts.

THE KINSLER-BENNETT CO., Inc.

254 Market Street, HARTFORD, CONN.

The American Distributing Co.
Direct Factory Representatives
Kresge Bldg. Detroit, Mich.

THE NAME "Exide"

on an automobile starting and lighting battery means that it is made by the oldest and largest manufacturer of storage batteries in the country.

That it is the battery of unit cell construction, with the patented airtight cell cover and non-flooding filling plug.

That it is the improved type of the "Exide" battery, which was the first successfully used battery for automobile starting and lighting.

That it is the type of battery which has given service satisfaction to hundreds of thousands of car owners throughout the country.

That it is the battery which

"Costs most to make, but least to use"

The Electric Storage Battery Co.

The Oldest and Largest Manufacturer of Storage Batteries in the Country

1888 PHILADELPHIA, PA. 1917

New York Boston Washington Minneapolis Denver Detroit
San Francisco Kansas City Chicago Cleveland Atlanta
Pittsburgh St. Louis Rochester Toronto

POSITIONS & MEN AVAILABLE *Cont.*

Men Available (Concluded)

0447. ASSISTANT ENGINEER OR DRAFTSMAN. Ten years' experience with automobiles, trucks, tractors, airplanes, gas engines, starting equipment and automatic machinery. Latest work on airplane engines. Familiar with every branch of modern practice for obtaining standardization and interchangeability. Has given special attention to drafting-room organization. Thirty years old. Married.

0448. ENGINEERING GRADUATE from the University of Wisconsin desires a position with an automobile or airplane company doing government work. Testing, experimental or inspection work preferred.

0449. MECHANICAL ENGINEER, experienced in design and inspection work, desires change of position. At present in charge of drafting and design, having 90 draftsmen and clerks under his charge in large industry kindred to the automotive industry employing between 5,000 and 10,000 men. Change desired to broaden experience and increase possibilities.

0450. AUTOMOTIVE ENGINEER, thoroughly experienced in designing and reproduction of motor cars, desires position as chief engineer with a progressive motor car company.

0451. MANAGING AND EXPERIMENTAL ENGINEER, large experience, especially in the development, testing and manufacture of gasoline and kerosene carbureters. Desires position as designing or chief engineer, preferably with company making carbureters. References given upon request.

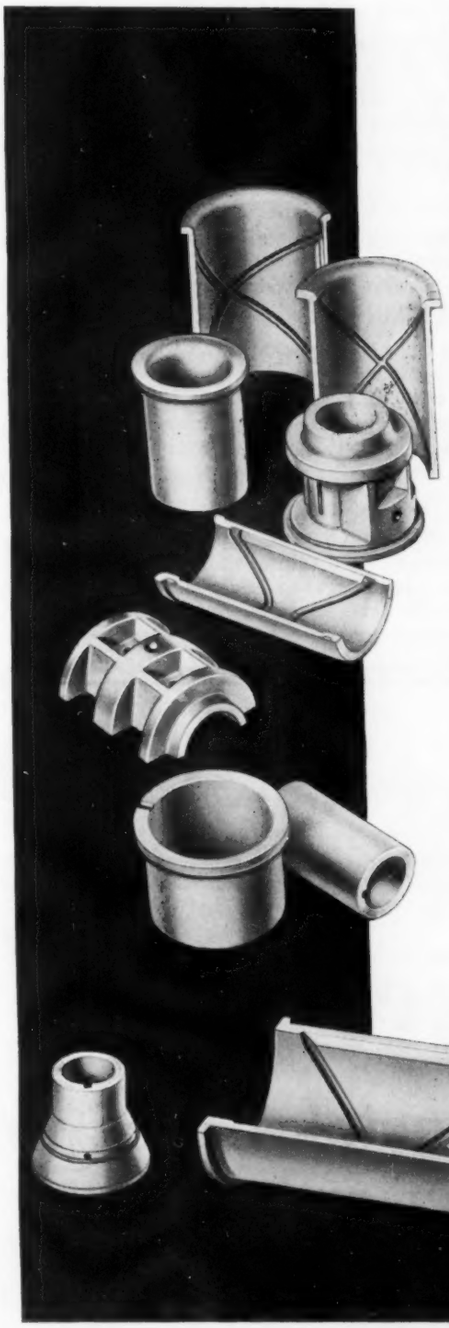
0453. MECHANICAL ENGINEER with twenty years' experience. Designer of several successful tractors manufactured on large scale. Has held positions as chief engineer, chief draftsman and superintendent. Can submit excellent records of service. Capable of introducing new line of light tractors or improving present line. Desires to negotiate with responsible tractor or automobile company wishing to enter tractor line.

*0454. HIGH-GRADE BODY ENGINEER, desirous of becoming located with an up-to-date reliable firm which offers inducements for advancement to a man who has proper qualifications and ability and is able to take advantage of an opportunity when offered. Especially competent to install system, handle men and take charge of the development, design and construction of all types of automobile bodies. At present employed. Salary not less than $6,000.

0455. DESIGNER, fourteen years' technical and practical experience in magneto and battery ignition systems. Inventor of several ignition devices now successfully on the market, well acquainted with starting and lighting systems, capable of designing up-to-date machinery for production in above line. Four years in executive position with large

(*Continued on page* 56)

Franklin Die-Cast Bearings



The Result of Fifteen Years' Study of Automobile Bearing Requirements

WHETHER you are pouring your bearings, using sand castings machined or babbitt lined bronze shell construction, Franklin Die-Cast Bearings will prove an attractive proposition, both from the standpoint of quality and price.

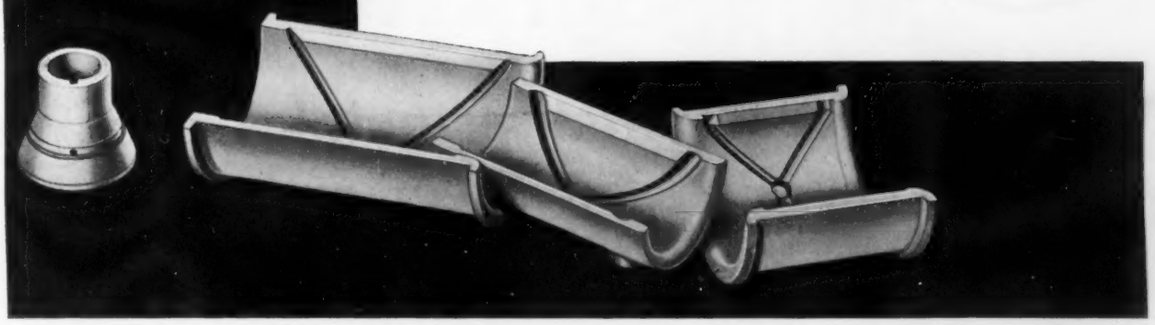
Our metals range from our B or Premier Babbitt, which is a high-grade tin, antimony and copper alloy, representing the best alloy obtainable for high speed and heavy duty, down to the babbitt with large lead content for slow speed work.

The new Franklin factory affords ample facilities for the meeting of your die-casting requirements, insuring prompt and satisfactory service.

Franklin service is the result of fifteen years' study of the die-casting possibilities as applied to automobile construction.

Send samples or blue prints for quotation or request a call from one of our representatives.

Booklet "A" on Request



Franklin Manufacturing Company

755 Gifford St., Syracuse, N. Y.

S. A. E. MEMBERS

Attention

The Society desires to obtain copies of 1916 and 1917 BULLETINS and of Parts I and II of the Transactions.

Members who have any of these copies and who are willing to dispose of them are requested to notify the S. A. E. Office, 29 West 39th Street, New York City.

POSITIONS & MEN AVAILABLE *Cont.*

Men Available (Continued)

automobile firm. Desires connection with electrical or automobile firm as experimental, research or production engineer.

0456. ENGINEER, capable of taking charge of engine department or testing laboratory. Considerable experience with dynamometer testing on both automobile and aviation engines. Available about December, with preference to locate within 100 miles of New York.

0457. REPAIR MAN, experienced in Quartermaster Corps repair shops. Familiar with defects developed by army trucks on Border and construction details conducive to accessibility. Desires position with manufacturer producing new army truck.

0459. SALES AND GENERAL MANAGER with fifteen years' experience in engineering work and six years as executive. Desires to get in touch with accessory manufacturers having openings. Location, New York City preferred. Salary $5,000. Contingent arrangement with bonus or commission will be considered.

0460. FOREMAN. Seven years' experience as general foreman in machine shops and two years' experience as designing engineer. Desires to obtain a similar position with concern manufacturing automotive parts.

HYDRAULIC

Quality and Service

Are the fundamental principles back of every Pressed Steel article

Manufactured by

THE HYDRAULIC PRESSED STEEL CO.

CLEVELAND, OHIO

Government Openings

One of the military departments of the U. S. Government is looking for some high grade engineers who are experienced in installing and operating modern drafting room systems. Chief draftsmen of unusual executive ability might qualify. Right men will either be given commissions or added to civilian personnel. The work offers an opportunity to S.A.E. members to be of the greatest service to the Nation. Replies should be sent to Executive, care of Society of Automotive Engineers, Inc., 29 W. 39th St., New York.

A good car PROPERLY upholstered is a pleasure.

ANY car not PROPERLY upholstered is a "thorn in the flesh".

No car is as GOOD as it COULD BE unless upholstered with JACKSON cushion springs.

JACKSON CUSHION SPRING CO.
JACKSON, MICH.

Packard TRUCKS
ADOPT
PREST-O-GRIPS
For U. S. Government War Orders

The Anti-Skid Chain with the Positively Closed Lock-Link Easily Attached and Detached

Engineers of Truck Companies
Write Us for Reasons Why PREST-O-GRIPS Should Be on Your Trucks

PREST-O-GRIPS are made in all sizes of clamps and all lengths of chain to fit every model of truck.

Dealers supplied through established accessory jobbers.

The Rowe Calk Co.

Factory and Sales Offices
Plantsville, Conn.

Executive Offices
Hartford, Conn.

THE "DEPPÉ INTEGRATOR"

is the name by which the complete system of producing superheated fixed dry gas from mineral oils and air, will be known in future.

The Deppé Integrator combines a preheater for air, a carburetor to meter air and oils, centrally opening throttle to accurately spray the mixture into a mechanical atomizer and diffuser, a vaporizing chamber, a gasifying chamber, and a superheating chamber.

The superheated fixed dry gas made under the Deppé methods, remains a gas during its passage through intake valves and to the bottom of the intake stroke of piston, thus avoiding lubricating oil dilution, slow combustion on power stroke, prevents overheating of engines, gives increased power over wet mixtures, as well as greater fuel economy.

Handles true gasolines or cracked gasolines even when made from 2/3 of the average crude oils, instead of cracked gasolines made from 18% of the crudes, as now sold by oil refiners.

Deppé Motors Corporation
34 Pine Street New York City

The Use and Abuse of Ball and Roller Bearings

By F. J. JAROSCH, Chief Engineer
of the Bearings Company of America

This booklet is being used as an authority by many of the leading engineers to-day. It will assist in finding the true cause of trouble and will tell how to overcome it.

The Use and Abuse of Ball and Roller Bearings should be a part of every engineer's library.

Send for it (booklet 95-G.); it is free.

Joseph Dixon Crucible Co.
Jersey City, N. J.
Established 1827

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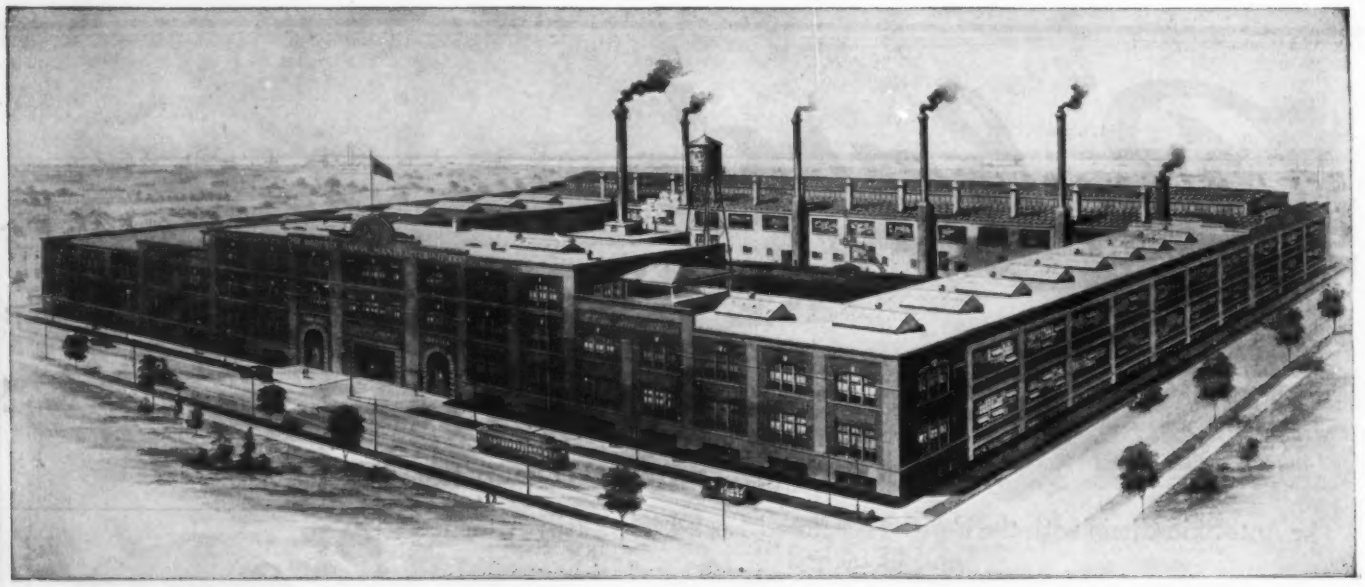

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Are prepared to furnish BRASS PARTS for

AEROPLANES and AERO ENGINES

in addition to our regular line of BRASS PARTS for

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Seamless Steel Leakless Gasoline Tanks

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Performance Tests

on

Internal Combustion Motors

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Trucks — Tractors — Airplanes — Cars
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Confidential Development Work and Engineering Research a Specialty

Facilities for Tests of Accessories and Fuels — Carburetors, Plugs, Rims, Tires, Headlights, etc., etc.

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THE TESTING LABORATORY
of
THE AUTOMOBILE CLUB OF AMERICA

FREDERICK R. HUTTON, Chairman, Technical Committee
MANCIUS S. HUTTON, Laboratory Engineer

THREE FOR YOUR CONSIDERATION

Gasoline Tank Gauge
Licensed Under
Patent No. 712070

Nagel Ammeters

Priming Cups

A GASOLINE TANK GAUGE of popular design which is accurately sensitive to the slightest variation in gasoline level. Fitter mounting and cap are special and made to drawing as required.

NAGEL AMMETERS, made in two sizes, are regular equipment on Remy and Electric Auto-Lite systems on such cars as the Overland, Chevrolet, Mitchell and Oakland.

Our COMBINATION PRIMING CUP AND PET COCK is a very practical one, dimensions of which can be altered to conform with your requirements

We are manufacturers of special small screw machine products and stampings.

THE W.G. NAGEL ELECTRIC CO.
28-30-32 ST. CLAIR ST.
TOLEDO, OHIO.

BASCO

GREASE CUPS AND OILERS

Styles for all purposes.

Pelton Clips for use in place of clevis connections.

Send for samples and catalog.

The Burns & Bassick Co.

Division of

THE BASSICK CO.

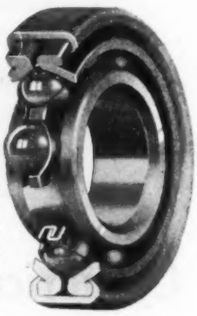
Bridgeport Connecticut

SCHATZ "UNIVERSAL" Annular Ball Bearing

EFFICIENCY ACCURACY

HIS internationally standardized combined radial and thrust bearing sustains successfully from 300% to 400% more thrust load than any other known annular bearing.

No pleasure car, truck or tractor will ever see sufficiently hard service to wedge or jamb the balls in its "Universal" bearings.



Write for Catalog and Data Sheets

You will be interested in studying the unique features which enable the "Universal" bearing to lead the field in thrust capacity **without adjustment** and without **impairment of annular efficiency.**

The "Universal" takes end thrust in either direction; has an inner race a third deeper than the average; an outer race in two units; a rivetless separator; a three area contact **a quality throughout** that establishes **a new high standard** in the manufacture of ball bearings.

THE FEDERAL BEARINGS CO., Inc.

30 WILLIAM STREET POUGHKEEPSIE, N. Y.

"UNITED" Alloy Steels

Never before has the quality of steel been of such vital importance.

For heavy duty trucks and aeroplanes, where life and strength are essential properties, "United" Steels are being regularly specified.

Our customers depend upon us in emergencies just as they have in the past for their every-day requirements.

United Alloy Steel Corporation

Canton, Ohio

MOTOR TRUCK STAMPINGS

Heavy equipment is required in order to produce economically many of the parts required for large trucks.

We are fortunate in having among our large presses in operation the largest single-crank geared power press ever built.

Manufacturers of motor-truck parts are invited to submit specifications for our estimates.

THE BOSSERT CORPORATION

Manufacturers of SHEET METAL STAMPINGS

Office and Factory UTICA, N. Y. — New York 30 Church Street

We Manufacture
FEATHER-WEIGHT SEMI-STEEL

PISTONS

Exclusively

Quantity Production

To Your Own Specifications

Figures cheerfully given without obligation
Send us your Blue Prints

The Dall Motor Parts Co., *Vermilion, O.*
Detroit Office: 965 Woodward Ave.

The Mark of Quality

TOLEDO STEEL CASTINGS

DELIVERIES? Ask our Customer

QUALITY? Ask his Engineer

PRICES? Ask US

WE ARE SPECIALISTS, so

Put your problems up to our engineers and metallurgists

THE TOLEDO STEEL CASTING CO.
TOLEDO, OHIO, U. S. A.

ZENITH CARBURETOR

THE ACME OF SIMPLICITY PRECISION RELIABILITY PERMANENCE

KNOWN the world over as the *zenith* of carburetor efficiency. A long list of American builders of cars, trucks and aeroplanes believe this simple, plain tube device to be the best insurance for permanent carburetor satisfaction.

ZENITH CARBURETOR CO.

NEW YORK DETROIT CHICAGO
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DROP FORGINGS OF QUALITY

We are specialists in the manufacture of drop forgings for

AEROPLANES
AUTOMOBILES
AUTOMOIBLE PARTS
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Equipped to give prompt action

Send in blue prints or
Samples for quotations.

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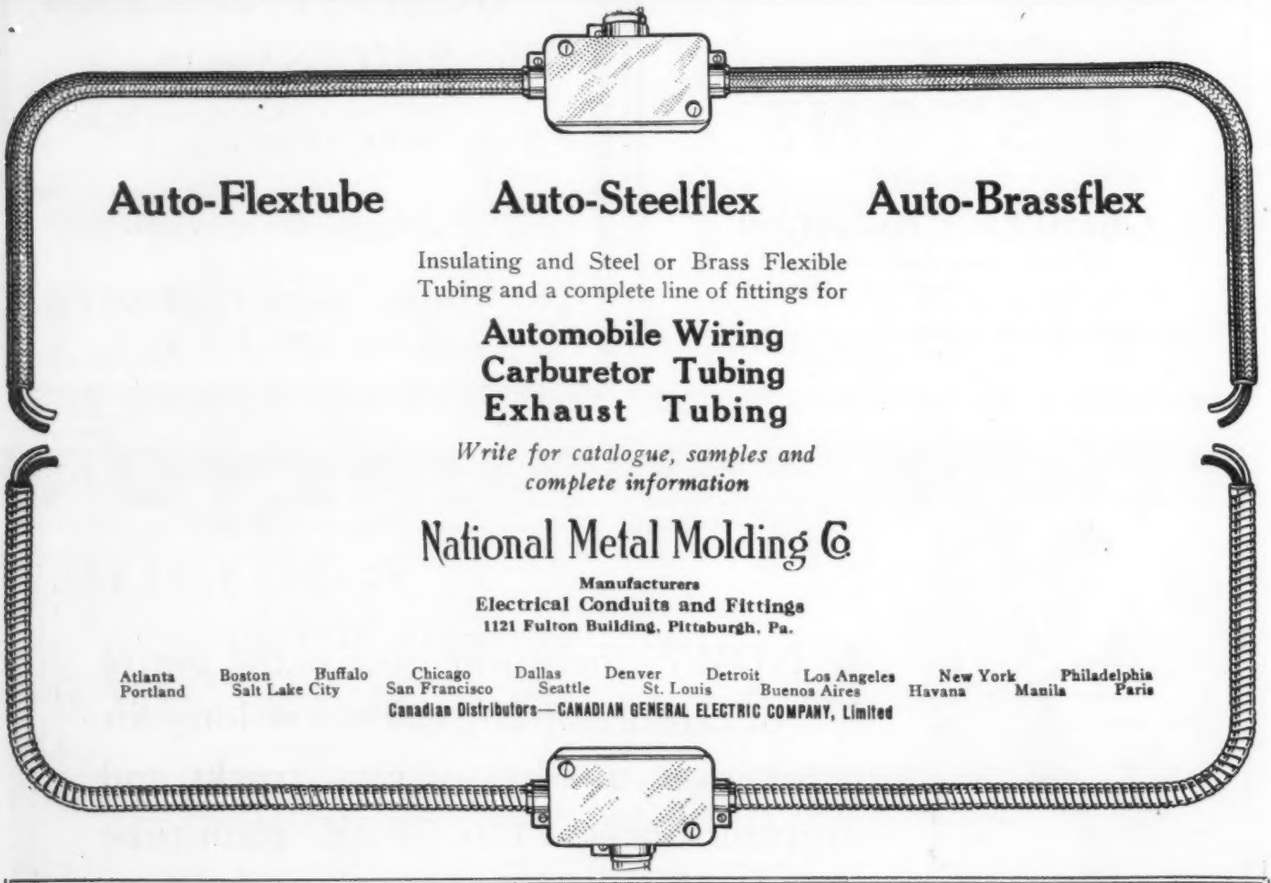
ENDICOTT, N. Y.



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Insulating and Steel or Brass Flexible
Tubing and a complete line of fittings for

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Write for catalogue, samples and complete information

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DROP FORGINGS

THE WHITMAN & BARNES MANUFACTURING CO.

ESTABLISHED 64 YEARS

1000 WEST 120th STREET, CHICAGO, ILL.

SHIMS

.001 INCH THICK AND HEAVIER IN BRASS, STEEL OR COPPER

Send us your Blueprints and let us figure on your requirements

KALES STAMPING COMPANY

448 LAFAYETTE BLVD. - - - - - - - - DETROIT, MICH.

ECLIPSE-
BENDIX
DRIVE

ECLIPSE MACHINE CO.
Elmira, N. Y.

Sylphon
TRADE MARK

AUTOMATIC TEMPERATURE CONTROL
FOR
Airplanes, Automobiles, Trucks, Tractors, or Other Vehicles Using Water Cooled Motors.

In the heating trade, Sylphon Specialties are the recognised standard—In the automotive field they are the pioneers and keeping pace with its marvelous development.

The largest plant in the world devoted exclusively to the manufacturing of Temperature Controlling devices.

THE FULTON COMPANY

New York Knoxville, Tenn. Chicago

Exhibits at both New York and Chicago Shows

SEAMLESS HELICAL TUBE COOLING SECTIONS

are guaranteed for the life of the truck on which they are installed. They are perpetual insurance against radiator trouble. They satisfy all of the exacting requirements of the most critical engineers. They are the last word in modern radiator construction.

¶ Ask us for information.

¶ Our Engineering Department is at your service.

Radiator Insurance

♣ ♣

Sole Manufacturers

Rome-Turney Radiator Co.
Rome, N. Y., U. S. A.

We are ready now to start producing

15,000 PERFECT STARTERS

This is no idle boast, but a prophecy and pledge of our readiness to do our part in equipping America's air fleet. Every "Perfect Starter" delivered will be constructed with the same wonderful fool-proof and durable features, as was the one recently

Tested by Navy Officials who have pronounced the test "Perfect"

All "Perfect Starters" are interchangeable on 4-, 6-, 8-, and 12-cylinder motors; 100 H. P. to 600 H. P. No Piping—No Changes On Motor—Light In Weight. To Army, Navy, and officials of airplane manufacturers we will give details.

THE MOTOR COMPRESSOR COMPANY

52-60 Dickerson Street **Newark, New Jersey, U. S. A.**

Spicer Universal Joints

Universally Accepted as the Most Dependable Flexible Connection Known to Motor Car Practice

Grease-Tight Dust-Proof

PARTS INTERCHANGEABLE

SPICER MFG. CORP., South Plainfield, N. J.

Sales Representatives

L. D. Bolton, 2215 Dime Savings Bank Bldg., Detroit
A. H. Coates, 41 Spear Street, San Francisco
Foreign: Benjamin Whittaker, 21 State Street, New York

Moulded Insulation

as produced by the
Dane Manufacturing Co.,
is *your* asset.

We shall be glad to describe to you our
Mould and Tool
facilities for handling your requirements

Send us Your Specifications
and Drawings

Dane Manufacturing Co.

333-341 Sixth Ave.
Newark, N. J.

COLUMBIA STEEL & SHAFTING CO.

MILLS AND GENERAL OFFICES PITTSBURG, PA.	EASTERN SALES DEPARTMENT AND WAREHOUSE BOSTON, MASS.

MANUFACTURERS OF
COLD DRAWN AND DIE ROLLED ROUNDS, HEXAGONS, SQUARES, FLATS, SPECIAL SHAPES, SCREW STOCK, AXLE AND ALLOY STEELS
COLUMBIA TURNED AND POLISHED STEEL SHAFTING
THE LARGEST AND MOST COMPLETE STOCK OF COLD FINISHED STEELS
MONTHLY STOCK LIST ISSUED

SCREW STOCK

After many years of careful experiment, we have adopted and now use for free cutting screw stock a specially selected analysis steel, which owing to its absolute free cutting and threading properties has proved among the authoritative consuming trade to be admirably suited and best adapted for use at high speed, with maximum production of parts, in such as the automatic and hand screw machine and turret lathe operations.

Complete equipment with every facility to offer the very best products, provides, and extreme care with close attention to the requirements of our trade insures, such uniformity of structure and accuracy sufficient to substantiate the claim of superiority (based on expression of trade opinion) in "Columbia" free cutting screw steel.

SALES OFFICES: CHICAGO CLEVELAND DETROIT PHILADELPHIA

PRESSED STEEL AUTOMOBILE FRAMES

FOR TRUCKS AND PLEASURE CARS

Originators and manufacturers of Heat-treated Frames

PARISH MANUFACTURING COMPANY

DETROIT, MICH. READING, PA.

HY-TEN STEEL

HIGH GRADE STEELS FOR EVERY PURPOSE

STRENGTH
TOUGHNESS

UNIFORMITY
SERVICE

Neither a bow knot nor a doughnut but a piece of HY-TEN A-Temper as rolled—bent cold.

HY-TEN is made in twelve distinct grades, thereby providing a steel suitable for practically every machine part.

Orders are assured prompt attention by our large and complete stocks carried in our warehouses.

WHEELOCK, LOVEJOY & CO.

23 Cliff Street
NEW YORK

128-160 Sidney Street
CAMBRIDGE, MASS.

1800-1802 Columbus Road
CLEVELAND, OHIO

Communicate with the nearest Office

UNION DRAWN STEEL CO.

General Offices: Beaver Falls, Pa. Works: Beaver Falls, Pa., and Gary, Ind.

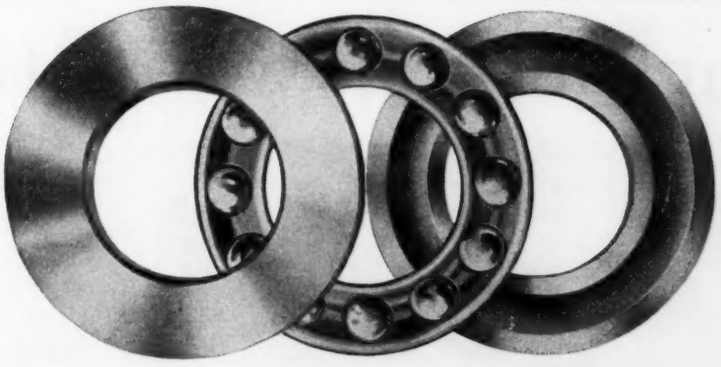
COLD DRAWN OR TURNED AND POLISHED

- Shafting
- Screw Steel { BESSEMER / OPEN HEARTH
- Alloy Steels (Heat Treated or not) { NICKEL—1% AND 3½% / NICKEL CHROMIUM / CHROMIUM / CHROMIUM—VANADIUM, ETC.
- Axles, Piston Rods
- Special Shapes
- Special Case-Hardening Steels

Cold Finished Bessemer, Open Hearth, Crucible and Electric Furnace Steels

BRANCHES:

New York Detroit Cincinnati Boston Philadelphia Chicago Buffalo



BALL THRUST BEARINGS

BALL RETAINERS FOR CUP AND CONE
MAGNETO AND THRUST BEARINGS

UNIVERSAL DRIVES DROP FORGINGS

Western Office
Ford Building, Detroit

The Bearings Company of America
Lancaster, Pa.

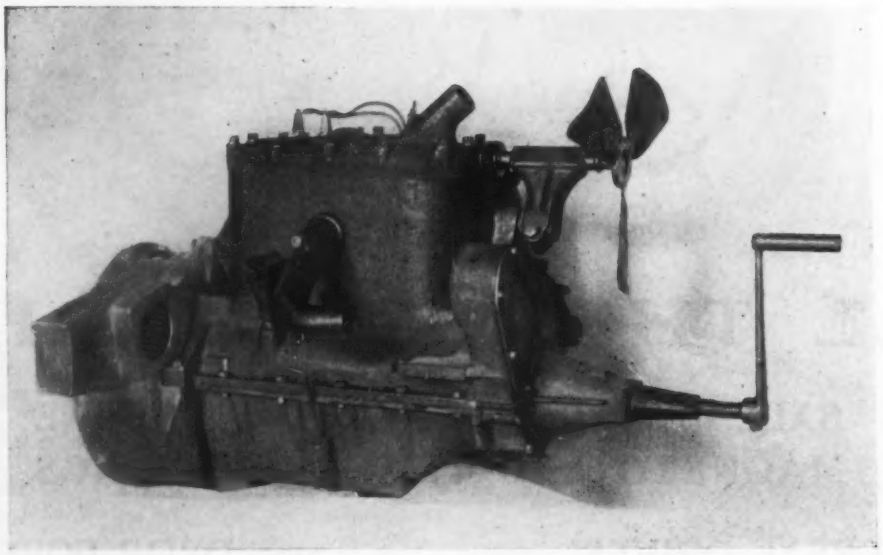
SMITH PRESSED STEEL FRAMES

Our own Chemical and Physical Laboratory checks all of the materials used in Smith Frames. Quality in materials is our first requirement.

A. O. Smith Corporation

MILWAUKEE, WIS.

A Detachable Flywheel Housing



Model H-D 3-¼ x 4-½-in. Four-cylinder Motor.

is one of the exclusive features of our four-cylinder truck motor. Built with open flywheel or with No. 4 or No. 5 S. A. E. flywheel housing. Designed for 1000 or 1500-lb. trucks or for light tractors.

We shall be glad to describe to you the many exclusive features of this motor.

LIGHT MANUFACTURING & FOUNDRY CO.

POTTSTOWN, PA.

The Straw that Broke the Camel's Back

was an insignificant item—in itself.

But for the sunken road of Ohain Napoleon might have conquered the World. A thousand parallels might be drawn, all pointing to one answer:

You Cannot Afford to Overlook Small Details

You cannot afford to spend thousands of dollars on a Motor Car and then "sell your reputation—for a song" by neglecting to specify the best FUSES; an insignificant item in any event.

"Noark" Automobile Lighting Fuses

are the best that money can buy.

Manufactured by

The Johns-Pratt Company, Hartford, Conn.

H. W. JOHNS-MANVILLE CO., Sole Selling Agents

DU PONT FABRIKOID
REG. U. S. PAT. OFF.

TRUCK SPECIAL

As Rugged as the Service It Is Made For

Behind the Firing Line or on the Busy Street TRUCK SPECIAL Meets Every Test of Service

Uncle Sam is using leather substitutes for truck upholstery. You will if you investigate the real economy and splendid wearing qualities of TRUCK SPECIAL.

It is water-, grease-, and stain-proof and cleanable. It insures maximum comfort, cleanliness and durability.

Write for samples and prices

DU PONT FABRIKOID CO.
Wilmington, Del.

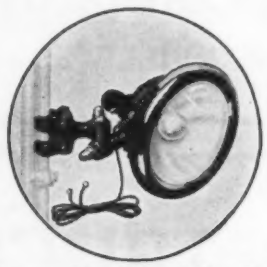
Victor
TRADE MARK

Victor Spotlamp Doors match your car lamps

Harmony between spotlamp and headlamps is just as necessary as harmony between one headlamp and another.

The Victor is the only spotlamp which offers doors designed to match the different headlamps found on leading cars.

Go to your dealer and get the Victor specially intended for your car. You will find it the most convenient as well as the most beautiful spotlamp you can buy.



Standard Lamp, No. 50 and No. 51—Price $5.00

If your dealer doesn't carry the Victor write us

The Corcoran Victor Co.

Reading Road Cincinnati, Ohio.

Meeting the Challenge

During Wagner's twenty-five years' active participation in electrical development, the trained ability of Wagner engineers has been called upon to meet the challenge of fresh needs daily.

THE WAGNER STARTER

The Starter That Is Built to Order

could not be built "ready made" for any car on the market. Our standard demanded that every starter equipped should form the starting *complement* to the efficiency and capacity of that particular car.

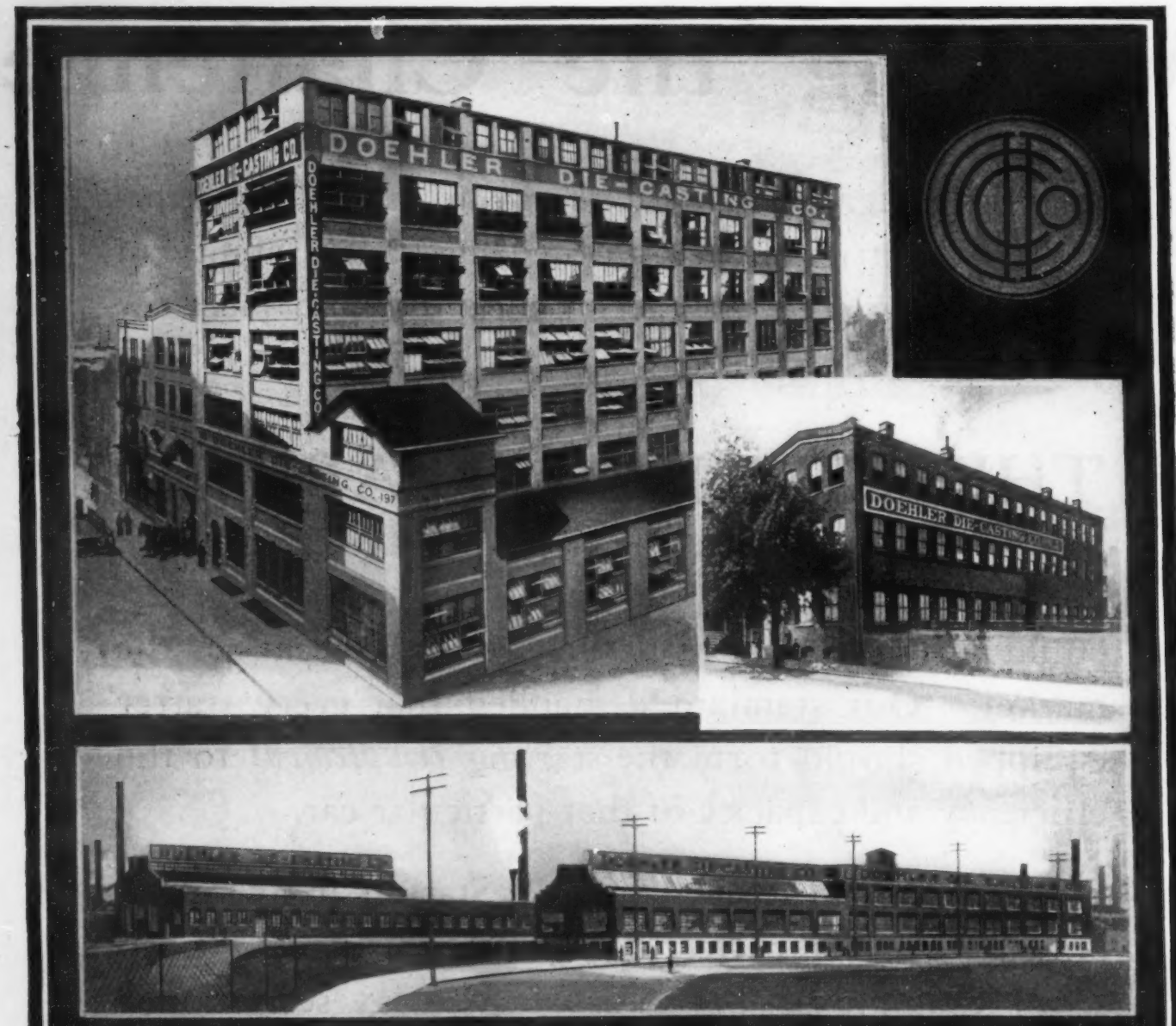
Everyone of the 200,000 Wagner Starters in operation does its work in perfect harmony with the car. Each is an example of the unusual everyday service that Wagner, Quality has stood for since the beginning.

Wagner Electric Manufacturing Co.

St. Louis, Mo., U. S. A.

Factory Branches and *Maintenance Stations: *New York, *Chicago, *Philadelphia, *St. Louis, *Boston, *Cleveland, *Pittsburgh, *Detroit, Buffalo, *San Francisco, Milwaukee, Cincinnati, *Los Angeles, *Minneapolis, *Kansas City, Seattle, *Indianapolis, St. Paul, *Denver, *Portland, *Atlanta, Syracuse, Springfield, Mass., Montreal, Toronto

Selling Agencies: New Orleans, Memphis, Salt Lake City, Dallas, London, Eng., Melbourne, Australia



The combined area of these three plants aggregates the largest floor space in the world devoted to the exclusive manufacture of Die-Castings.

DOEHLER DIE-CASTING CO.

MAIN OFFICE AND EASTERN PLANT
BROOKLYN, N.Y.

WESTERN PLANT
TOLEDO, OHIO.

NEW JERSEY PLANT
NEWARK, N.J.

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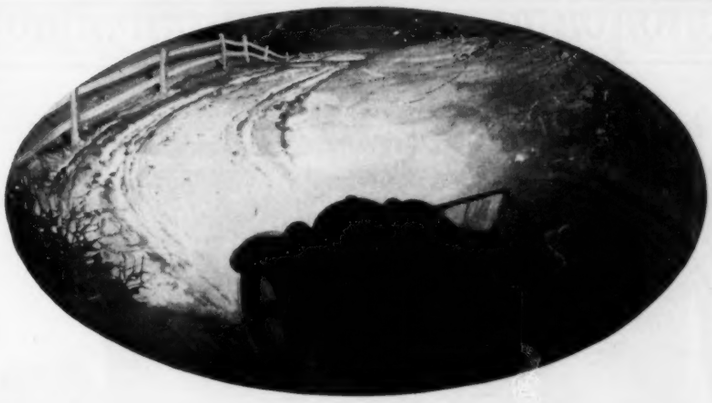
4414 NO. CAMPBELL AVE.	914 FORD BUILDING	726 GRANITE BUILDING	723 OLIVER BUILDING

WARNER-LENZ

Legal Under Every Law

Used on 850,000 Cars



WARNER-LENZ

No Direct Beams

Adopted by 21 Car Makers

A Lawful Light

That's ALL-Revealing—No 42-inch Limitations

THE Warner-Lenz is legal under every state or local law forbidding glare. This has been certified to by countless authorities, and by every commission appointed under any state headlight law. There are no direct beams, no glare rays. So Warner-Lenz light is not restricted to 42 inches above ground.

Users get far-reaching, wide-spread, all-revealing light. A flood of soft, diffused light illumines one's whole field of vision.

The road and roadsides, far and near, are lighted, the curves and turns, the upgrades and the downgrades.

Rise and fall of the car does not affect the light, as with level rays. Nor does turning of the lens in the lamp-rim.

The Warner-Lenz is the preferred lens. That is evident everywhere. Over 850,000 cars now have them. They have been adopted as standard equipment by the 21 car makers named below.

It is the best known lens. We have spent $330,000 to advertise it in the past twenty months. No other motor car accessory—except tires—has ever been equally advertised.

It has been endorsed for specific reasons by many of the ablest engineers in Motordom. Their letters will be sent on request.

Glare lights are now forbidden by 22 statewide laws. Also by countless local laws. The best way known to comply with those laws is with the Warner-Lenz. Please let us prove that to you.

Standard Equipment on

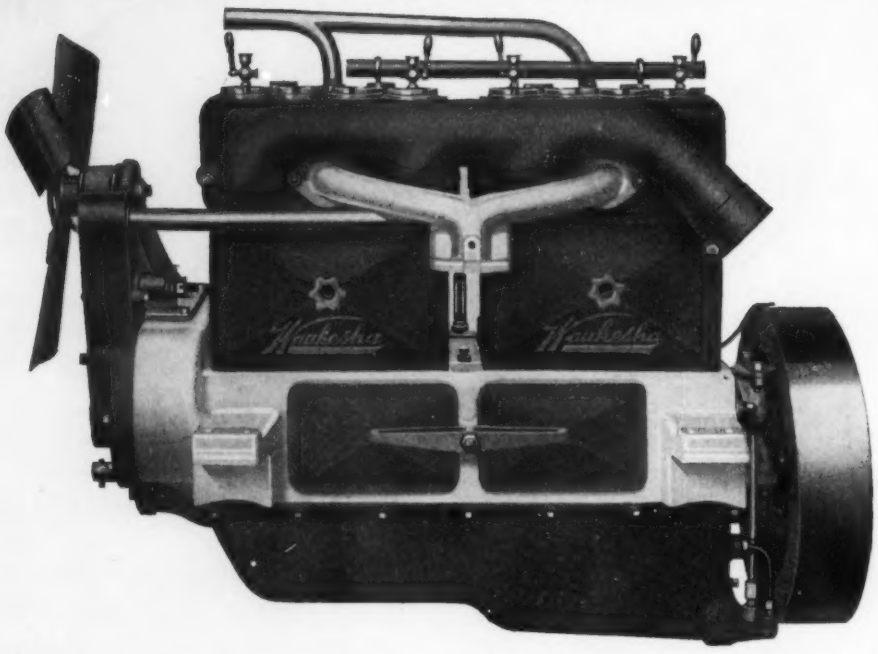
Packard	Moon
Marmon	Standard 8
Stutz	Pathfinder
Hal Twelve	Doble Steam
White	Singer
Fiat	Daniels 8
Ohio Electric	McFarlan
Lenox	Murray
Peerless	Davis
Fageol	Cunningham
Crawford	

WARNER-LENZ

This is A. P Warner of the Warner Auto-Meter Fame, and Inventor of the Magnetic Speedometer

THE WARNER-LENZ COMPANY

921 South Michigan Avenue, Chicago, Ill.



Hardship is the Test of Character

Under normal conditions mediocrity may endure, but true character alone will survive life's severest ordeals. In designing

Waukesha
TRADE MARK

Four-Cylinder Motors for Trucks and Tractors

a wide margin of strength and power (motor character) is allowed for those crucial moments which call for extraordinary performance.

The result is motors of such exceptional character that their proven reliability has been rewarded by the confidence of the nation.

"Demand a Waukesha Motor in the Truck or Tractor You Buy"

WAUKESHA MOTOR CO., Waukesha, Wis.

World's Largest Builders of Truck and Tractor Motors Exclusively

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Will be Exhibited at the Chicago Automobile Show, Space 94, Coliseum Gallery

PER and SIDE GUIDE

Sample of No. 3595			
Laboratory No. 15,931.			
From The Dayton Steel Foundry Co.			
Silicon	.28	Physical Analysis	
Manganese	.70	Tensile Strength	66,980
Phosphorus	.020	Elastic Limit	42,870
Sulphur	.042	Elong.	32.5%
Combined Carbon.	.26	Reduct.	54.1%

Respectfully submitted.

C. A. Kurz Chemical Laboratories

Per *W. Y. Kurz*

Date Reported 10-19-17. *M.C.B.*

In the Last Analysis

Dayton Steel Wheels

show their worth. Whether in the laboratory or in the daily, grueling grind on the truck, Dayton Steel Wheels have no equal in strength, long life and resiliency.

Dayton Steel Wheels will outlast the truck itself, and their lightness and elasticity add to the life of the engine, chassis and tires.

Specify Dayton Steel Wheels and rest assured in the confidence that they will give added worth to your trucks.

The Dayton Steel Foundry Co.

Dayton, Ohio

CINCINNATI, O.
422 First Nat. Bank Bldg.

DETROIT, MICH.
1102 Chamber of Commerce

NEW YORK CITY
416 World Bldg.

PER and SIDE GUIDE

LIBERTY AXLES

Engineering genius of the highest order, skilled workmanship and materials the best obtainable, combine to create and prove the quality of Liberty Axles.

Look over the specifications shown on this page. Check them carefully. You'll find that we have not hesitated to profit by the experience of others —that we have accepted only those principles of axle construction of proved worth and soundness. And it is upon these principles that we base our claim of superiority for Liberty Axles.

Specifications

Ribbed axle and worm and gear housings cast from open-hearth steel. Also axle spiders, which are bolted on each side of main axle casting. They also support the brakes.

Axle shafts are of chrome-vanadium steel, machined to 2¾", heat-treated and ground to size. Flange ¼"x3½" holds bearings in shape and prevents axle from slipping sidewise.

Bearings: Two double thrust U. S. Ball Bearings on each axle, also two supporting the differential; U. S. Radial and Thrust Bearings at front and rear of worm. Sizes used have been tested and proved right in service.

Worm and Gear of David Brown type. Worm of special alloy steel, gear of special bronze, both ground to size. Gear ratio, 7¾ to 1.

M & S Differential Two-Piece housing of open-hearth steel. Special device holds worm gear in place.

Chrome-vanadium steel driving gears and pins. Brakes, dual double internal expanding, of our own design. Simple, effective, easily adjusted.

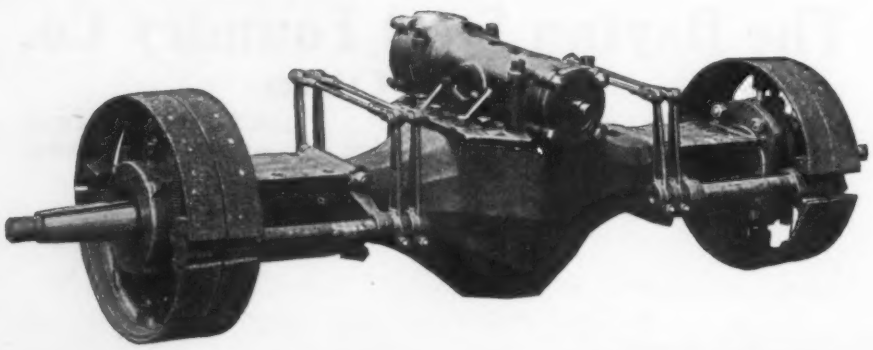
No truss rods—greater road clearance.

Spring centers as desired.

Track: Front 58¾", rear 61".

WAGNER AXLE COMPANY

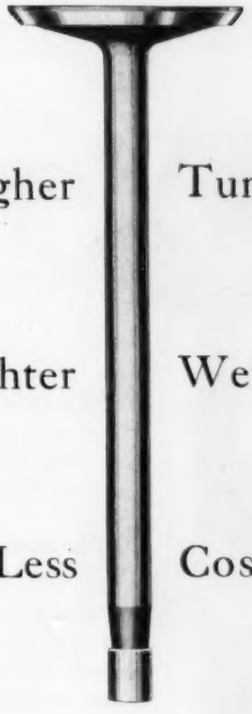
Anderson, Indiana, U. S. A.



Formal Announcement

FANSTEEL

Higher Tungsten Valves



Higher Tungsten

Lighter Weight

Less Cost

We Are Prepared for
Increased Production

PFANSTIEHL COMPANY, Inc.

NORTH CHICAGO ILLINOIS

for SEVERE SERVICE

The Plug with the Green Jacket

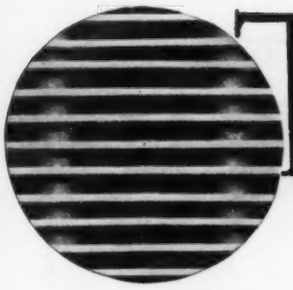
For constant hard work—where you must be SURE of a spark every time—use SPLITDORF Plugs—the imported India ruby mica insulation cannot be harmed by hard usage. It cannot chip or crack—and it is always leak-proof.

Sure and Easy Starting

is assured on medium and large size stationary and marine engines with SUMTER Plugoscillators and on tractors, trucks and heaviest duty motors with SUMTER Starter-Couplings. Your manufacturer will give you the equipment if you INSIST.

SPLITDORF ELECTRICAL CO.
NEWARK, N. J.

SPLITDORF
SPARK PLUGS



Truck and Tractor Radiator Types

An explanation of the features of continuous fin tubular construction.

FIRST of all, continuous fins mean the most satisfactory cooling. They distribute the heat so evenly throughout the core that this type of construction will show, by careful tests, greater radiation per cubic inch of core and per pound of copper. At same fan speed, a higher air velocity can be obtained through the core.

The cooling is so efficient that a less depth of core may be used as compared with tubular radiators of other types.

The ability to withstand shocks and bumps is another feature of the continuous fin type of radiator. The minor knocks and bumps that are continually occurring in the operation of a truck or tractor rarely injure the continuous fin type. This is because the stress is distributed over the entire core and because the fins are reinforced with steel wire in their front edges.

Where a bump might completely ruin several individual tubes, it will not affect the core when the stress is distributed.

This fact has been demonstrated many times by a man jumping onto a continuous fin core without injuring it in the least.

The fins also act as stabilizers for the tubes, preventing vibration. This eliminates one of the principle causes of leaks in other types of tubular radiators.

The importance of this distribution of the stress of shocks and the elimination of vibration cannot be overestimated. A truck or tractor must stand hard service if it is going to be of value to its owner. The radiator cannot be less serviceable than other parts of the car.

The only accident that can demolish a continuous fin type core is one that breaks the radiator frame casting or actually penetrates the core.

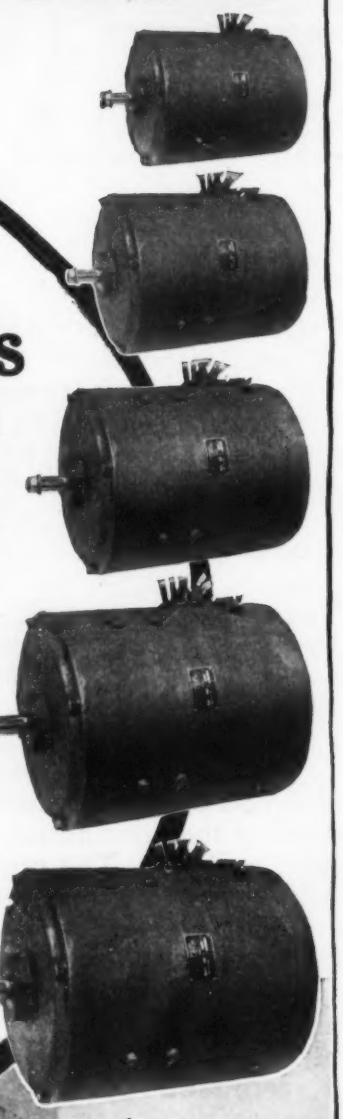
The continuous fin type offers an advantage over other types in the matter of repairs. A leaking tube may be loosened with a blow torch and pulled through the head sheet, allowing for the insertion of another tube in its place, whether of the outer or inner rows.

There are other points which might be of value to the engineer and we will gladly enter into discussions with those who are interested.

This firm manufactures all types of radiators. But we do not want to supply any motor vehicle manufacturer with radiators which will not provide the most efficient cooling. Therefore we feel an obligation to make plain to engineers and manufacturing executives the features of the different types of radiators.

McCORD MANUFACTURING COMPANY · DETROIT · MICHIGAN

Westinghouse
Electric Vehicle Equipment



A Motor To Meet Your Needs

"Speed Up Production" is the slogan that is being used throughout the land. Each industry is producing at its utmost capacity, yet there is need of greater output.

Specify **Westinghouse Electric Vehicle Equipment** on your trucks and tractors to meet the additional service required of them.

These motors have three points that make many of the leading truck and tractor manufacturers use them—Liberal Overload Capacity—Unusually large commutator area can be furnished for either lead or alkaline battery service.

The controllers are of the continuous torque type, giving smooth and efficient acceleration. The fact that the current is not broken from step to step insures long life.

Westinghouse Engineers are ready to consult with you on your problems. Write for information.

WESTINGHOUSE
ELECTRIC & MANUFACTURING CO.
East Pittsburgh, Pa.

W
WESTINGHOUSE ELECTRIC

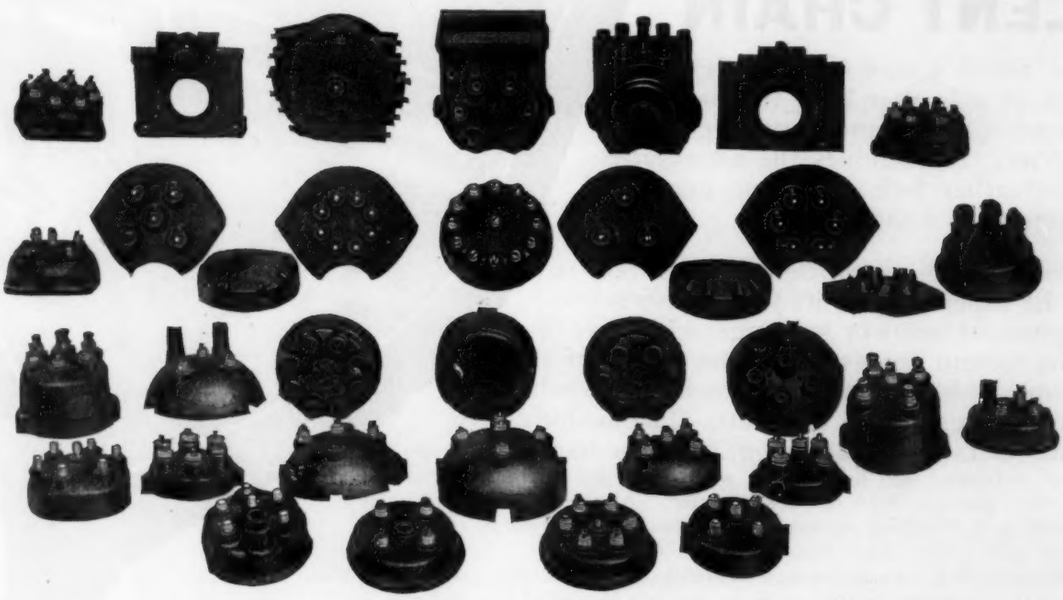
FLEET OF WALKER TRUCKS-BUSH TERMINAL-BROOKLYN, N.Y.

"TRY BOONTON"

The Answer given by AUTOMOTIVE ENGINEERS when asked for advice about INSULATION

MOLDED INSULATION

PARTS FOR IGNITION APPARATUS, BOTH MAGNETO AND BATTERY SYSTEMS



We have designed tools and helped design the parts for all the prominent makers of **IGNITION APPARATUS.**

Our compositions have been thoroughly tested and tried out.

We were the first successfully to mold condensation products commercially.

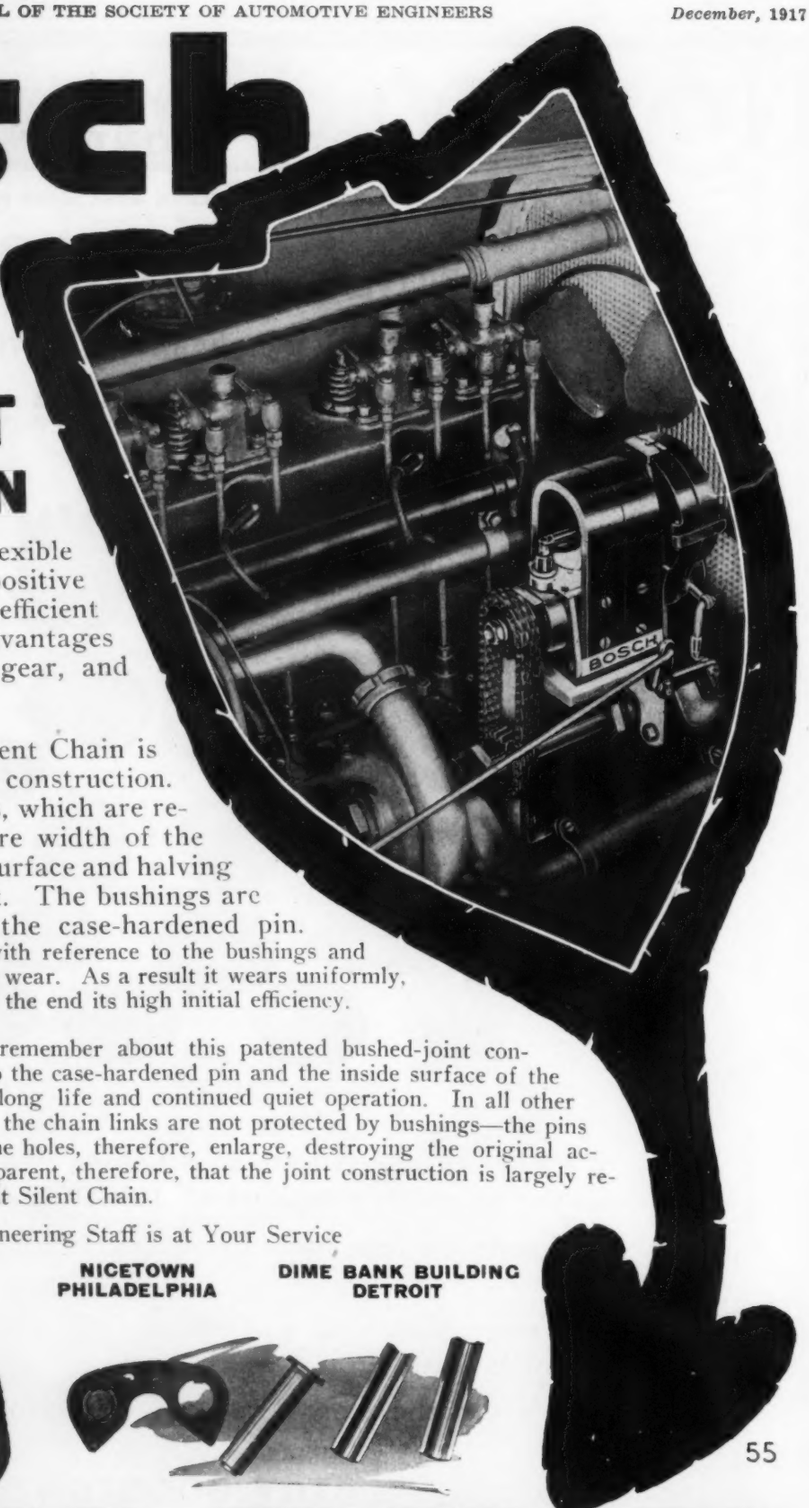
That's why the answer to your insulation problem is

"TRY BOONTON"

BOONTON RUBBER MANUFACTURING COMPANY

BOONTON, N. J.

Bosch Uses



LINK-BELT SILENT CHAIN

because Silent Chain has the flexible qualities of a leather belt, the positive action of cut gears, and is more efficient than either. It combines the advantages of both leather belt and spur gear, and eliminates their disadvantages.

The success of the Link-Belt Silent Chain is due to the superiority of its joint construction. The segmental liners or bushings, which are removable, extend across the entire width of the chain, thus doubling the bearing surface and halving the bearing pressure on the joint. The bushings are case-hardened, and bear upon the case-hardened pin. The latter is free to and does rotate with reference to the bushings and presents every particle of its surface for wear. As a result it wears uniformly, keeps round, and the chain maintains to the end its high initial efficiency.

The important point for car owners to remember about this patented bushed-joint construction is that it limits natural wear to the case-hardened pin and the inside surface of the case-hardened bushings—which means long life and continued quiet operation. In all other silent chains wear is more rapid because the chain links are not protected by bushings—the pins come in direct contact with the links; the holes, therefore, enlarge, destroying the original accurate pitch of the chain. It will be apparent, therefore, that the joint construction is largely responsible for the success of the Link-Belt Silent Chain.

Our Experienced Engineering Staff is at Your Service

LINK-BELT COMPANY NICETOWN PHILADELPHIA DIME BANK BUILDING DETROIT

55

LINK-BELT
Silent Chain Drives

My Standard of Service

Before I go any further I want you to know that I'm an actual Willard Service man. The picture above is my real portrait. Thousands of car owners know me, and will recognize it. I'm selected by the Willard organization to represent Willard Service, and I'm going to tell you exactly what we mean when we talk about our standard of service.

First: meeting every customer *more* than half way, being really glad to see him, and glad to help him.

Second: being *properly* equipped to help—thoroughly trained and experienced in all brands of battery care, construction and repair.

Third: maintaining a real station, in a good location, with space in which to do business properly.

Fourth: showing the car owner how to care for his battery and how to avoid things that will injure it and shorten its life.

Fifth: being businesslike, to base fair and just charges on knowledge of actual costs, to give good returns for every penny, and to carry an adequate stock of new batteries, rental batteries and repair parts.

Of course, we're human, and we're not all of us 100% all of the time; but we are honestly and sincerely striving to live up to our standard. We believe Willard Service is the most reliable battery service in America and we're making it better every day.

We welcome your suggestions.

Willard Service

Willard STORAGE BATTERY

No. 105 H

No Longer an Extra

The speedometer has graduated from the "extras"—has become a standard item of equipment consulted more frequently, perhaps, than any other instrument on the car. As an index of the manufacturer's equipment policy, the speedometer may prove a by no means unimportant factor in the competition for popular approval.

Designed to operate on the centrifugal principle, and combining accuracy, mechanical simplicity and freedom from trouble, the Johns-Manville Speedometer gets an unqualified "O.K." in that final "check up" of accessories a man makes when he buys a car.

There is a Johns-Manville Speedometer for every requirement—six models in all. The instrument illustrated (Cat. No. 105 H) is adaptable for flush mounting on practically any instrument board. The reset knob projects through the flush ring and is readily accessible from the driver's seat. This model is handsomely finished in black and nickel—3¼" dial with black face and white numerals, 60 mile speed scale, 10,000 mile season odometer. Details on request.

JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

H. W. JOHNS-MANVILLE CO.
New York City
10 Factories—Branches in 56 Large Cities

Johns-Manville Speedometers

Try Us on Bevel Gears

We've specialized on bevel gears. Our very large capacity and the fact that hundreds of thousands of our bevels are standard parts on leading automobiles, machine tools and other machinery places us in a peculiarly advantageous position to fill your orders as they should be.

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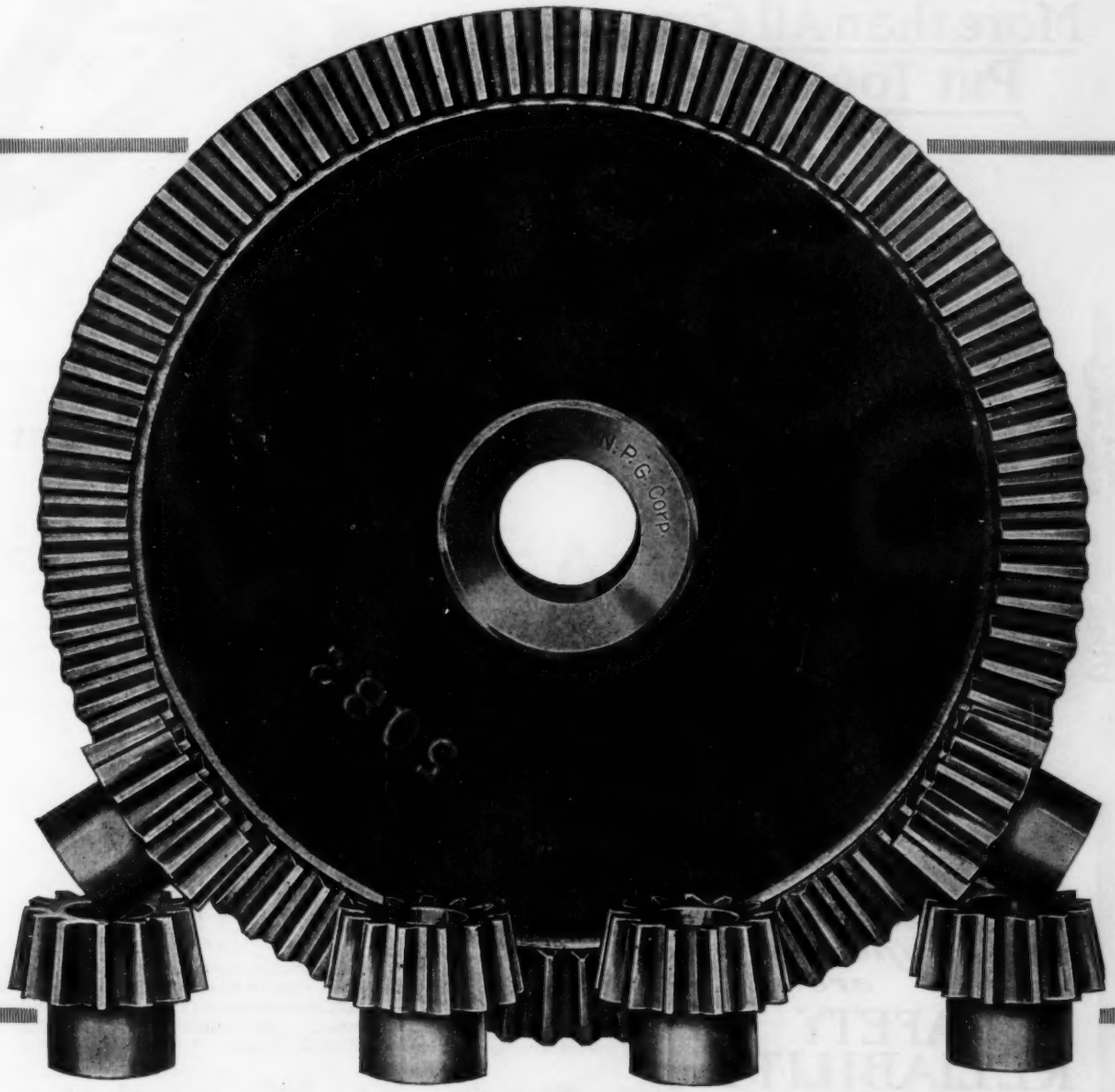

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78

Nearly 3 Times as Many as Nearest Competitor— Nearly 4 Times as Many as Next Competitor— More than All Competitors Put Together———

Fore & Aft Steering Gear

Here is the Record of ROSS GEARS as Steering Equipment on Motor Trucks

A VERY complete tabulation of technical specifications of 475 motor truck chassis, produced by 166 manufacturers, was published in Commercial Vehicle, Motor Age, and the Automobile and Automotive Industries for November 1, and Motor World for October 31.

The following figures give the Steering Gear totals, first as compiled from the printed tabulation, and then as corrected in accordance with absolute contracts and records of orders. These corrections place in the Ross column two from the nearest competitor, five from next competitor, one from another competitor, four that are listed as making their own steering gear, and eighteen not credited.

Steering Gear Equipment	As Printed	As Corrected
ROSS	203	233
First Competitor	83	81
Second Competitor	66	61
Third Competitor	18	18
Miscellaneous (divided among 6 manufacturers)	18	17
Not credited (granted to other manufacturers)	48	30
Total	436	440
Make own steering gear	39	35
Total	475	475

Not considering the truck manufacturers who make their own steering gears (that business not being open to competition), the figures in the corrected column show Ross Gears in use on 233 motor truck chassis, to a total of 207 for all other steering gear manufacturers put together—overwhelming evidence that Ross Gears are

The Steering Gears that PREDOMINATE on Motor Trucks

The Principal Points of Ross Superiority are

SAFETY RELIABILITY and EASY STEERING

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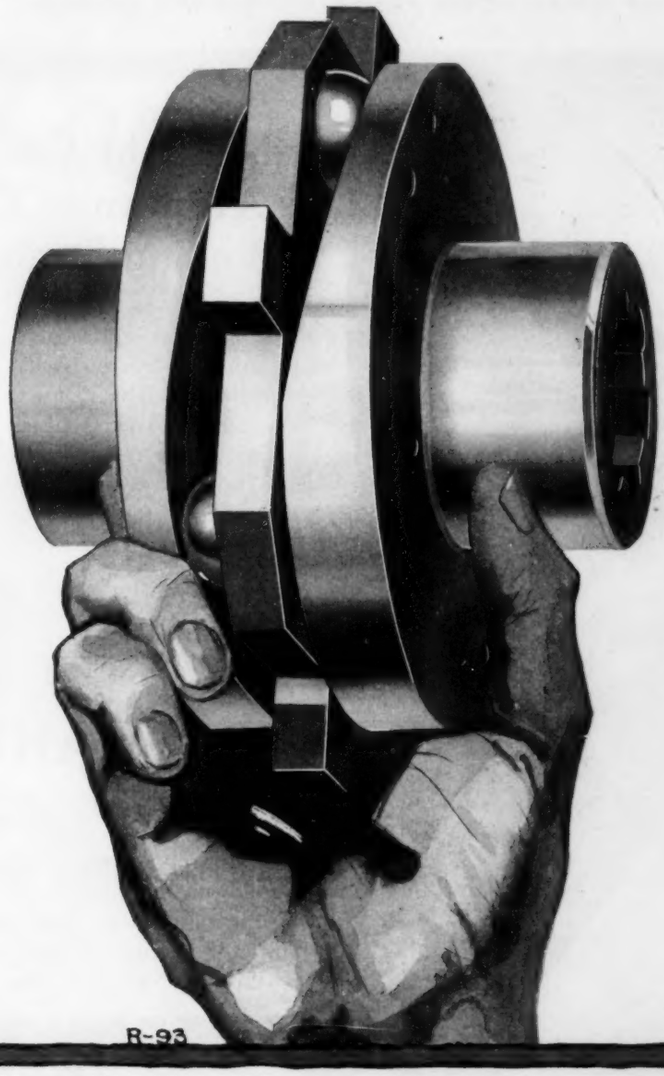

The Dorr Miller Differential assembled without differential housing

Built for Service

THE big husky driving plate; the eight sturdy 7/8" steel balls, each with a maximum crushing load of almost 20 tons; the large, generous, specially heat treated and hardened cam blocks. It looks, and is, built for service.

The Dorr Miller Differential is a *gearless* differential that transmits power *uniformly* to both rear wheels, irrespective of the traction surface of one wheel. It has all of the characteristics of a solid axle on straight-away pulling—yet instantly, positively and perfectly differentiates on the slightest turn. Simplicity is the keynote of its operation. The reverse cam action of the rolling balls in grooved raceways causes an internal resistance in proportion to the tendency of the tractionless wheel to spin.

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DORR MILLER DIFFERENTIAL

"The Differential that begs no Apology"

Does the Light Construction of Airplanes Cause Binding Strains?

The modern, high powered airplane, while rigid in construction, is made of the lightest possible materials, and is frequently subject to severe shocks and stresses which often distort the frame. This distortion throws the bearings out of alignment and often causes the moving shafts to spring slightly. The result of this disalignment in ordinary bearings is to cause cramping and binding, but in SKF Ball Bearings the self-aligning feature automatically adjusts itself to all movements of the shaft.

SKF
BALL BEARINGS

are used by the leading airplane constructors because they operate satisfactorily under conditions which would soon destroy a bearing incapable of automatically following the movements of the shafts on which it is mounted. Don't take a chance with inferior bearings at the vital power points. Specify SKF and soar with confidence.

SKF BALL BEARING CO.

HARTFORD
CONN.

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The Control of Quality

Point No. 6

What Accurate Piercing Means to Bearing Quality

In this piercing-mill solid bars of Timken steel are transformed in hollow tubes.

After many other operations in the Timken Tube Mill, they are turned over to the Factory to be turned into Cups and Cones for Timken Bearings.

The quality of tubing depends partly on the accuracy with which the outer and inner surfaces are made truly cylindrical about a common center.

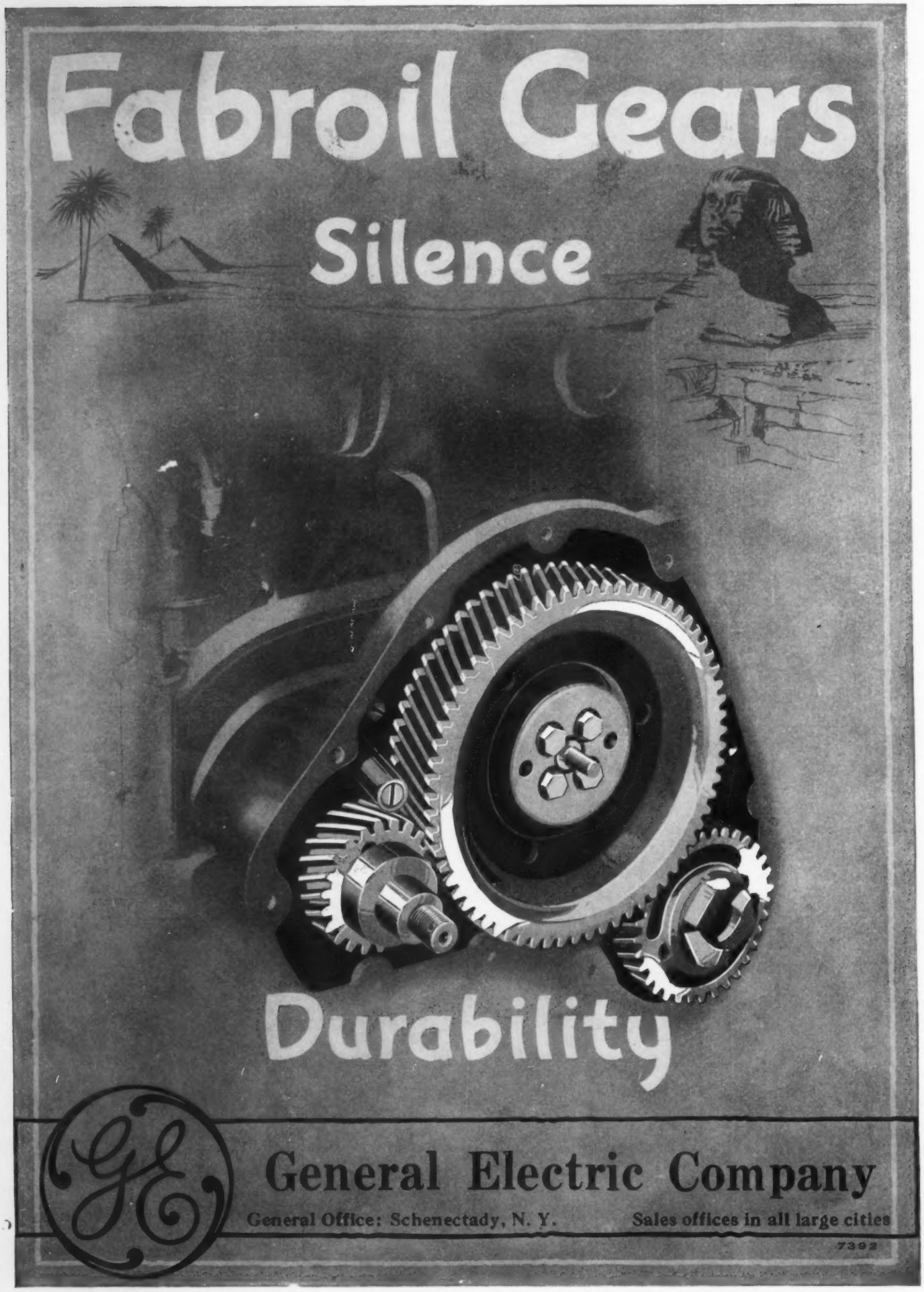
If either surface is slightly oval instead of round, or if the two have not a common center the tube is deformed, and the factory has not proper material to work with.

The care with which this piercing machine, greatly improved by Timken engineers, is operated, and the exact control of temperature in the furnace which "preheats" the bars—all play their part in Timken Control of Timken Bearing Quality.

THE TIMKEN ROLLER BEARING CO.
Canton, Ohio

Tube piercing machine in Timken Tube Mill.

TIMKEN BEARINGS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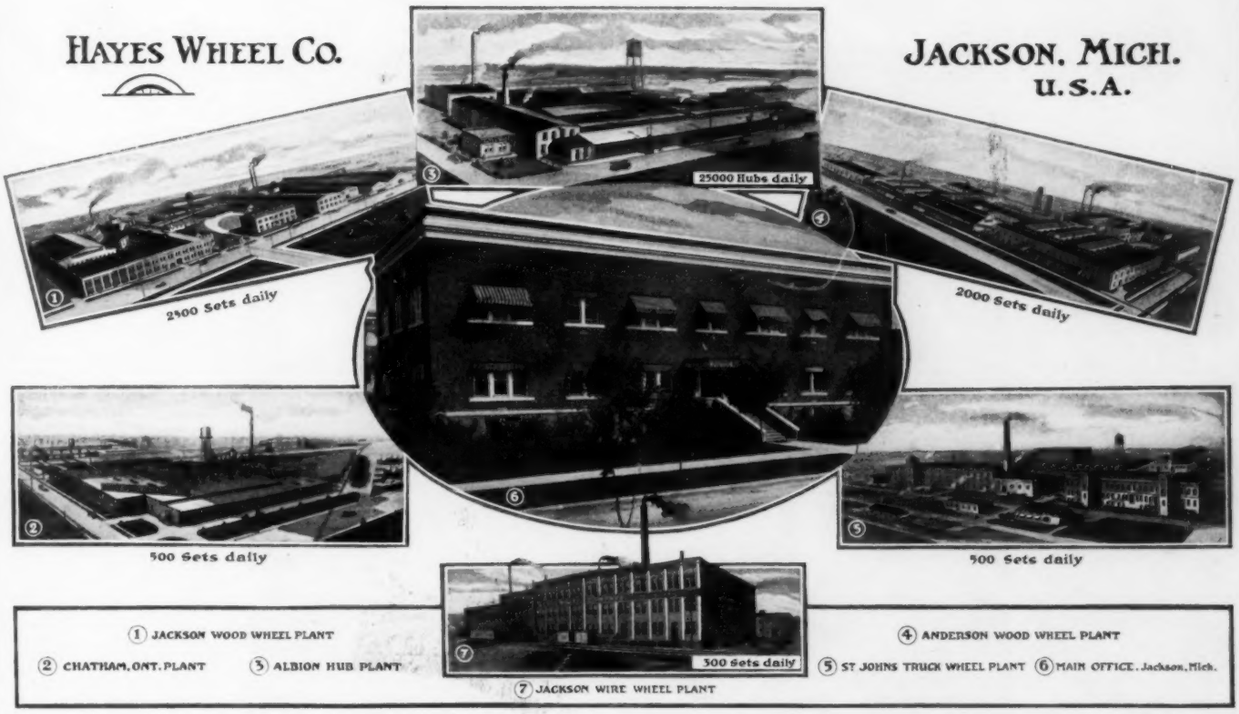

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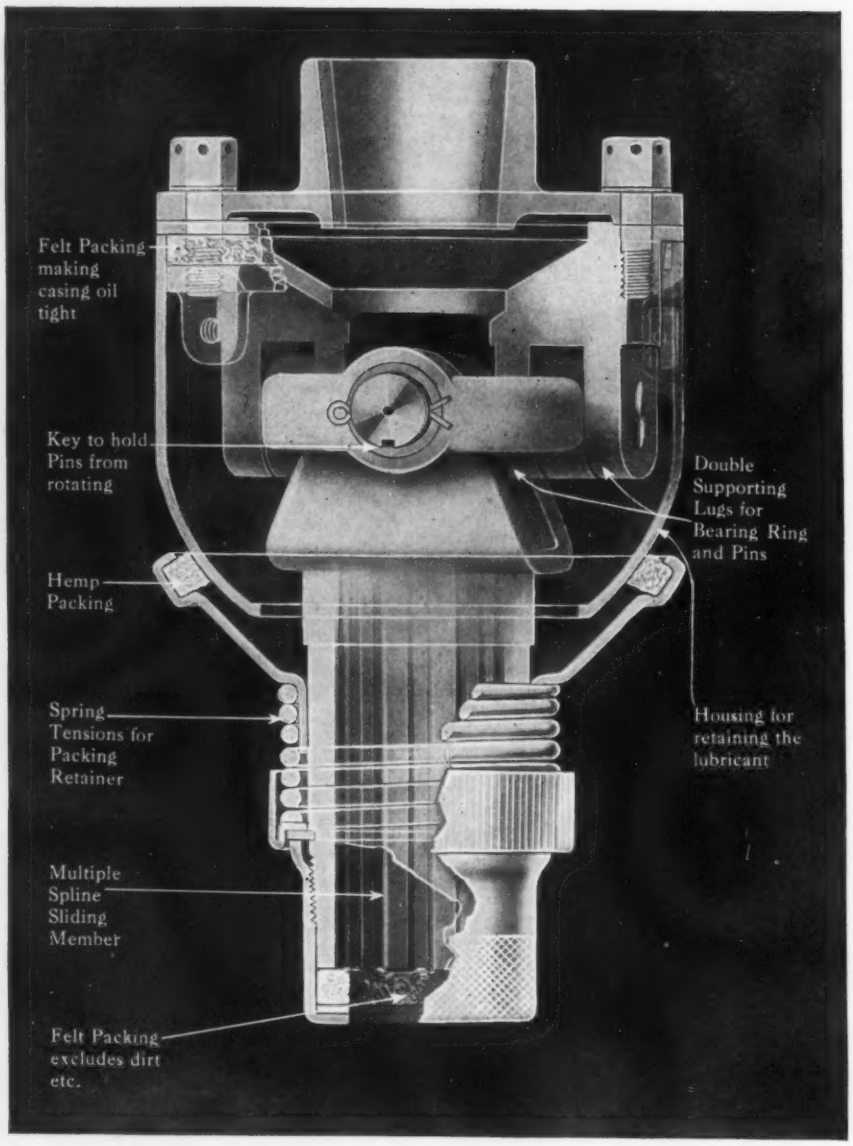
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1. Rusco Brake Lining is made from the best long fibred asbestos yarn interwoven with brass wire. The very least amount of cotton possible is used in spinning this asbestos yarn. (We specify brass wire because copper wire has proved inferior to brass after careful tests.)

2. Weaving: Both edges of Rusco Brake Lining are selvaged, using 12's three ply asbestos yarn, twisted around two brass wires. Solidly interwoven, there is no gutting or straight threads in its manufacture. There are in the warp 63 threads to the inch and in filling 21 threads to the inch.

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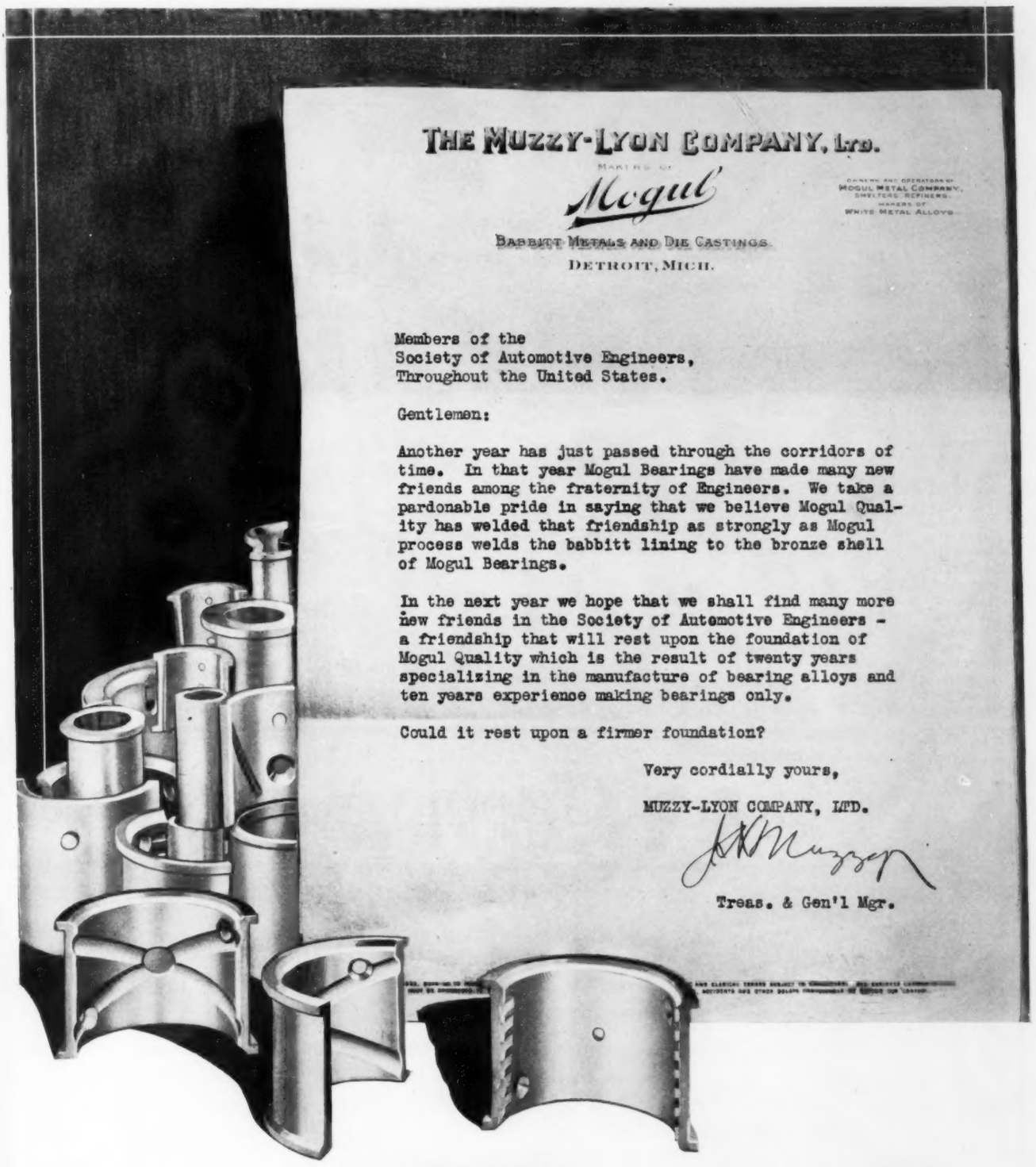
Steps, Running Board
Detroit Pressed Steel Co.


THE MUZZY-LYON COMPANY, Ltd.
MAKERS OF
Mogul
BABBITT METALS AND DIE CASTINGS
DETROIT, MICH.
OWNERS AND OPERATORS OF MOGUL METAL COMPANY, SMELTERS, REFINERS, MAKERS OF WHITE METAL ALLOYS
Members of the
Society of Automotive Engineers,
Throughout the United States.
Gentlemen:
Another year has just passed through the corridors of time. In that year Mogul Bearings have made many new friends among the fraternity of Engineers. We take a pardonable pride in saying that we believe Mogul Quality has welded that friendship as strongly as Mogul process welds the babbitt lining to the bronze shell of Mogul Bearings.
In the next year we hope that we shall find many more new friends in the Society of Automotive Engineers - a friendship that will rest upon the foundation of Mogul Quality which is the result of twenty years specializing in the manufacture of bearing alloys and ten years experience making bearings only.
Could it rest upon a firmer foundation?
Very cordially yours,
MUZZY-LYON COMPANY, LTD.
Treas. & Gen'l Mgr.

The Muzzy-Lyon
Company, Ltd.
Detroit, Michigan

Mogul

Bronze Babbitt lined *and* Die Cast Bearings

WHERE TO BUY EQUIPMENT SOLD BY S.A.E. JOURNAL ADVERTISERS

Strapping
Graton & Knight Mfg. Co.
Switchboards, Charging
Electric Storage Battery Co.
General Electric Co.
Wagner Elec. Mfg. Co.
Switches, Lighting and Starting
General Electric Co.
Westinghouse Electric & Mfg. Co.
Tanks, Acetylene
Prest-O-Lite Co.
Tanks, Air
Janney-Steinmetz & Co.
Tanks, Gasoline
Geuder, Paeschke & Frey Co.
Janney-Steinmetz & Co.
Tanks, Radiator
Aluminum Castings Co.
Tapping, Attachments
Whitney Mfg. Co.
Thermostats
The Fulton Co.
Timers
Splitdorf Electrical Co.
Tires, Pneumatic and Solid
Firestone Tire & Rubber Co.
Hood Tire Co., Inc.
Kelly-Springfield Tire Co.
Tire Straps
Russell Mfg. Co.
Top Materials
Du Pont Fabrikoid Co.
Torsion-Rod Assemblies
Michigan Plant, Steel Products Co.
Transmission Cases
Aluminum Castings Co.
Transmissions
Brown-Lipe Gear Co.
Link-Belt Co.
Morse Chain Co.
Tubes, Inner Tire
Firestone Tire & Rubber Co.
Hood Tire Co., Inc.
Tubing, Helical
Rome-Turney Radiator Co.
Tubing, Soft Rubber
Firestone Tire & Rubber Co.
Tubing, Steel
Frasse, Peter A., & Co.
Smith Corp., A. O.
Universal Joints
Bearings Co. of America
Hartford Auto Parts Co.
Kinsler-Bennett Co.
Spicer Mfg. Co.
Thermoid Rubber Co.
Upholstery Materials
Du Pont Fabrikoid Co.
Valves, Poppet
Lewis Steel Products Co.
Rich Tool Co.
Steel Products Co.
Valves, Tire
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Vanadium Alloys
American Vanadium Co.
Vanadium, Chrome
United Alloy Steel Corp.
Voltmeters
General Electric Co.
Nagel Electric Co., W. G.
Wagner Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.
Washers
Armstrong Cork Co.
Washers, Graphite and Bronze
Bound Brook Oil-less Bearing Co.
Washers, Oilless
Bound Brook Oil-less Bearing Co.
Washers, Special
Kales Stamping Co.
Washers, Wood
Bound Brook Oil-less Bearing Co.
Watches, Limousine
Waltham Watch Co.
Webbing, Passenger-Car
Russell Mfg. Co.
Welding, Autogenous
Prest-O-Lite Co.
Welding Equipment, Acetylene
Metals Welding Plant
Welding, Job
Metals Welding Plant
Wheels, Cast Metal
Hayes Wheel Co.
Smith Wheel
Wheels, Pressed Steel
Hydraulic Pressed Steel Co.
Wheels, Sprocket
Link-Belt Co.
Wheels, Wire
Standard Roller Bearing Co.
Wheels, Wood—Motor Truck
Dayton Steel Foundry Co.
Hayes Wheel Co.
Prudden Wheel Co.
Wheels, Wood—Passenger Car
Hayes Wheel Co.
Prudden Wheel Co.
Wire, Insulated
General Electric Co.
Wrenches
Whitman & Barnes Mfg. Co.

A Note on Getting Acquainted

THE items listed in this classified section of THE JOURNAL represent the products of the best known companies connected with the automotive industry.

Every regular advertiser is entitled to and does have a certain number of his products listed in this "Where to Buy" Section. He is requested, however, to list only those products of direct interest to the members of the Society.

S.A.E. Members are assured, therefore, that the products appearing on pages 96, 98 and 100 are there strictly for their benefit.

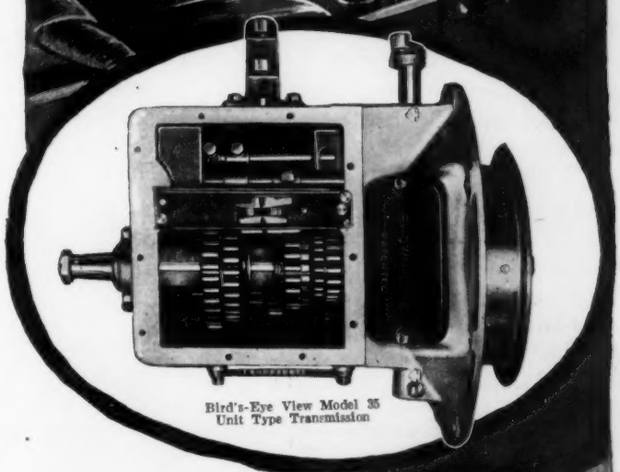
Also that it only takes two operations to get better acquainted with the maker of any of these products: (1) Turn to page 102, the Index to Advertising; (2) Turn to the page given in the Index and find there the introduction.

Think
When You Shift Gears

You are putting two great forces into conflict; the power of the engine against the resistance of the load.

The gears in the transmission, and the gears in the differential housed in the rear axle, play a more important part in car operation than you realize.

The quality of the steel, the design of the gear teeth, and the special heat treatment that gives them maximum wearing surface and strength are responsible for the reputation of

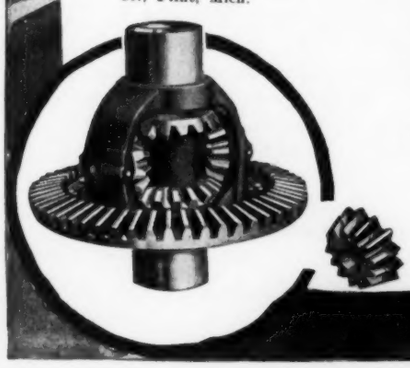


Bird's-Eye View Model 35 Unit Type Transmission

BROWN-LIPE
TRANSMISSIONS

Over 180 Pleasure and Commercial car manufacturers use either Brown-Lipe Transmissions or Brown-Lipe-Chapin Differentials as standard equipment.

Particulars will be furnished to owners, dealers and manufacturers on request.



Bevel Type Differential used by Dort Motor Car Co., Inc. Axles built by Walker, Weiss Axle Co., Flint, Mich.

BROWN-LIPE GEAR CO.
TRANSMISSIONS

BROWN - LIPE - CHAPIN CO.
DIFFERENTIALS

Factories and General Offices, Syracuse, N. Y.

REPRESENTATIVES:

NEW YORK: Thos. J. Wetzel, 29 W. 42d St.
SAN FRANCISCO: A. H. Coates, 444 Market St.
FOREIGN AGENT: Benjamin Whittaker, 2 Norfolk St., Strand, London, W. C.

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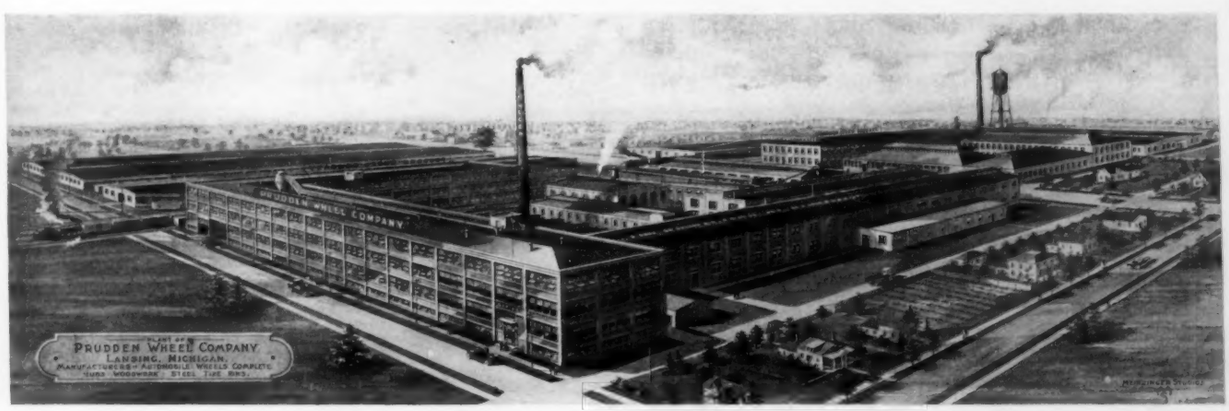
Prudden Wheels

PASSENGER CAR
LIGHT DELIVERY
TRUCK ATTACHMENT
HEAVY TRUCK

Complete With Woodwork—Hubs—Rims



Our New Steel and Concrete Addition
70' x 700' 4 Stories
Now Ready to Serve Automobile Manufacturers

The FINEST of SELECTED HICKORY is the only material entering our factory for the manufacture of WHEELS. This is why WE DO NOT HESITATE TO GUARANTEE PRUDDEN WHEELS FOR THE SERVICE FOR WHICH INTENDED, REGARDLESS OF LOAD OR ROAD CONDITIONS.

QUALITY WHEELS DEPENDABLE DELIVERY

PRUDDEN WHEEL COMPANY

MANUFACTURERS OF

AUTOMOBILE WHEELS COMPLETE

LANSING, MICH.

OUR facilities at Miami, Florida, and at Newport News, Virginia, permit us to take for aviation training immediately several more students on land and water machines.

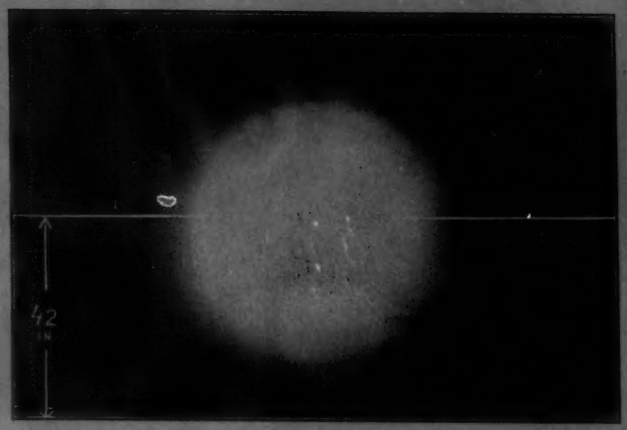
This offers an excellent opportunity for men to gain aviation training at old established schools where the best of instruction and a wide variety of types of aeroplanes, hydro-aeroplanes and flying boats are available.

Students will be accepted in order of enrollment.

Hundreds of Curtiss trained men are flying and teaching today in the United States Army and United States Navy and abroad.

For full information wire or apply

Curtiss Aviation School
Miami, Florida
or
Atlantic Coast Aeronautical Station
Newport News, Va.



Light from an ordinary automobile headlight projected on a screen placed 30 feet ahead of the car.

Conaphore beam projected on same screen. Note that light spreads and strikes below the 42-inch line.

Directs the light where it belongs

Proof that the Conaphore projects all the light on the road—none in approaching driver's eyes

With ordinary headlights, the intense rays from the reflector literally bore a hole into the night. Only part of the light hits the road. The rest shoots into the air to blind approaching motorists and pedestrians.

With Conaphores, all the light is shot along the road. The height of the beam is limited to 42 inches. The test photographs above tell the story.

Kills glare without cutting down range

The Conaphore has a series of patented corrugations on its inner surface. These bend down the light rays and distribute them along the road for 500 feet ahead. All glare is killed, yet no range is sacrificed. Patented cylinders in the center fan out the light over both roadsides.

Ordinary prismatic lenses fail to produce these results. They usually dump the light directly in front of the car and thus curtail range.

Diffusing devices simply scatter the light in all directions. If a high candlepower bulb is used to increase range, blinding glare is produced. With the ordinary bulb, glare is somewhat lessened, but you do not get the range you need.

THE CONAPHORE

Smooth front surface. Easily cleaned. Does not clog with dust, mud or snow.

Science designed the Conaphore

The design of the Conaphore has been worked out with scientific accuracy. It is mathematically correct in every detail. The same scientists who designed the Conaphore in the laboratories of the world's largest technical glass works, supervise its manufacture.

The Conaphore is made of Noviol Glass, the patented invention of the Conaphore designers. This special glass causes light to pierce fog, dust and snow flurries, and eliminates dangerous "backglare." This is because its unique yellowish-tint absorbs the blue and violet rays, so easily diffused by fine particles in the air. Also made in clear glass.

To automobile designers and manufacturers interested in solving headlighting problems, we offer the knowledge of our technical glass experts, and the resources of our specially equipped laboratories. Please feel free to consult us.

Put a pair of Conaphores on your own car. You will get new pleasure from driving at night.

RETAIL PRICE LIST

Noviol Glass	Per Pair	Clear Glass	Per Pair
5 to 6⅝ in. incl.	$3.00	5 to 6⅝ in. incl.	$1.00
7 to 8⅝ in. incl.	3.00	7 to 8⅝ in. incl.	2.00
9⅝ to 10 in. incl.	4.00	9⅝ to 10 in. incl.	3.00
10⅛ to 11⅛ in. incl.	5.00	10⅛ to 11⅛ in. incl.	4.00

Prices 25 cents more per pair west of Rocky Mountains. Sizes vary by steps of ⅛ inch above 6⅝ inch size.

CONAPHORE SALES DIVISION
Edward A. Cassidy Co., Inc., Managers
Madison Ave. & 40th St., New York City
CORNING GLASS WORKS

NO GLARE RANGE 500 FT. **CONAPHORE** **PIERCES FOG AND DUST**